REMINISCENCES AND LETTERS OF SIR ROBERT BALL

EDITED BY
W. VALENTINE BALL

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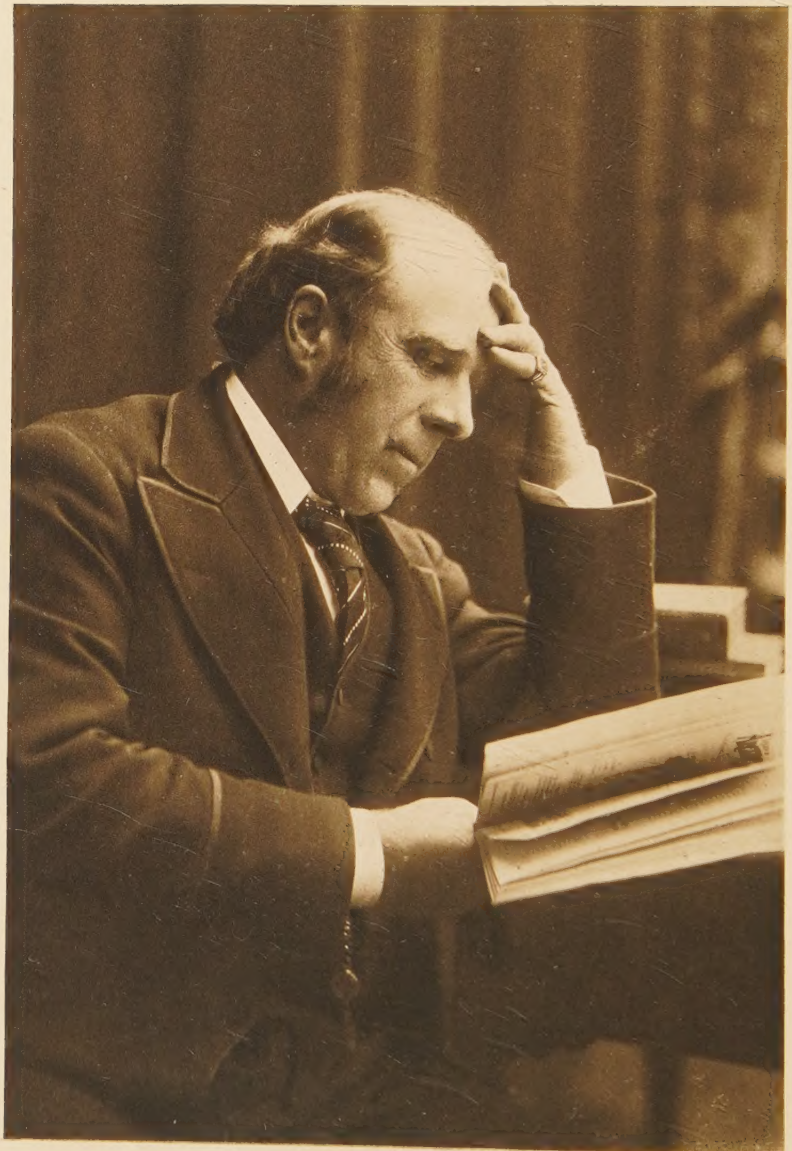

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Robert S. Ball

Reminiscences and Letters of SIR ROBERT BALL

Edited by his Son

W. VALENTINE BALL

With a Photogravure Frontispiece and Eight Plates

BOSTON
LITTLE, BROWN AND COMPANY
1915

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W. V. B.

PREFACE

In the year 1906 my father decided to publish his "Reminiscences." With this object in view he dictated a considerable amount of material. Before, however, he had made any serious inroad upon his store of pleasant memories, other duties compelled him to postpone the compilation for several years; failing health eventually prevented the completion of the work, or even the revision of the notes which he had dictated. It was at his request that I have undertaken the duties of editor. Although it is true that I have been able to record some matters which in his modesty he might have suppressed, it is to be regretted that the whole work was not prepared by himself.

In revising the autobiography, in the selection of further material, and in dealing with matters untouched by him, I have had constantly in mind a precept which I found noted in some rough memoranda which my father had drawn up for future use. It was:

"Try and give everything narrated a kind twist!"

It will be noticed that, subject to what appears in Chapter X. concerning the lectures on astronomy, the personal narrative brings the reader only so far as the date when my father left Ireland to take up the duties of Lowndean Professor at Cambridge. Of the last twenty years of his life he had prepared no record. An attempt has been made to fill the gap by making selections from his voluminous correspondence, and by giving in a more or less connected form some account of his many and varied activities.

I have published but few of his many letters to my mother and to members of his immediate family circle. For the most

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died in 1690, an eminent astronomer, and Peter Ball, M.D., who was also a student of astronomy. In 1674, Robert, of Bampton, emigrated to Youghal, County Cork.

For the benefit of English readers who do not know the correct way to pronounce "Youghal," I venture to reproduce a "Limerick" which I sent to Captain Riall, R.N., one of the Commissioners of the Irish Lights, with whom I had many a pleasant cruise when carrying out the duties of Scientific Adviser to the Commissioners *:

"There's a light in the harbour at Youghal,
Such a very good station and smoughal,
That the keepers elsewhere
One and all, I declare,
For that station incessantly boughal!"

In 1690 Robert Ball became Mayor of Youghal, and had a property known as Rocksborough (or Roxborough), near Midleton, in the same county. The coat of arms which he brought with him from Devonshire may be seen emblazoned on a window in the old church at Youghal. The escutcheon is near that of Sir Walter Raleigh, whose house adjoined the church. Raleigh's garden is one of the many places in which the local fire brigade is reputed to have attempted to extinguish Raleigh when he lit the first pipe in the Old Country!

Robert Ball was succeeded by his son Henry, of Sandy Hill, County Cork, and of Morebath Parish, Devon. He married Ruth Stawell in 1728, and from her family I take my second name. Henry had a son Robert (b. 1729). His son was born in 1768, and was christened "Bob Stawell." My father, who was the son of Bob Stawell, was born in 1802. I should have said that Henry Ball inherited the Youghal property, and also the property in Devonshire. He seems to have lost or parted with both estates, such as they were. My grandfather, Bob Stawell Ball, who died in my infancy, lived on in Youghal as a respected citizen. He eventually became mayor of the town. It thus comes about that I am a freeman of the town of Youghal at the present moment.

* * * * *

Thus far his own account. My father often used to say that he was probably one of very few living men who enjoyed

* See Chapter XI, *post*.

the freedom of London and of the town of Youghal. When the former honour was conferred upon him he wrote to his brother-in-law, Mr. Steele (May 24th, 1899):

"Do you know that your correspondent is a freeman—freedman—of the City of London—or, rather, will be after Saturday, when he is to be sworn in by Gog and Magog? I shall then be a freeman both of Youghal and London. The combination is, I think, interesting, and presents some instructive points of contrast. The average is, however, distinctly good. I am also a liveryman of a City company—the Spectacle Makers, to wit. What dreams of Turtle arise before my distempered vision at the prospect!"

Some further account of his connection with Youghal is contained in the following letter to his niece, Miss Maude Ball (August, 1906):

"The house that my grandfather, Bob Stawell, lived in, no longer exists. The site of it is now occupied by the buildings of the Provincial Bank. It is far up on the main street from the station end, on the right-hand side. My great-grandfather lived in the family place at Roxborough (I have not written it very plainly because I am not sure of the spelling!), near Midleton, between Cork and Youghal.

"John and Kitty Green lived on Nelson Hill, close to the church where your father and I spent many days in our youth. I forget the number of the house, but the sexton or any old person would show you where 'Kitty' Green lived.

"In one of the houses in the bank buildings Mrs. Sam Green used to live. There her children, Alice Green, Mrs. Loane, Sam, Edward, and Johnny, were all born. With them your father and I spent a month, during which we had many nice trips, such as to Capel Island, the cliffs of Ardmore and Glendyne. You have already, perhaps, gone to Ardmore to see the Round Tower and the cliffs, where Cornish choughs used to abound. Glendyne, which we also visited, is a lovely place, something like the Dargle. You ought to go there also.

"One of the last houses in Youghal that we frequented was on the Mall—a large house nearly opposite the Court House, on the station side. There Charles Green, father of Willy Green,* used to live, and there, not so very long ago, the last of his three old aunts died.

"It does please me so much to think that you take an

* His cousin, the Rev. William Spotswood Green, C.B., M.A., Government Inspector of Irish Fisheries since 1889. He is well known as an intrepid explorer, having been the first to ascend Mount Cook, New Zealand.

interest in these matters. Your account of the churchyard also interests me. The sextoness I saw two years ago was very glib in pointing out the inscriptions on the monuments in the church. But I could not get any good information from her about the Ball headstones. When she pointed out one monument in the church, and at the same time gave out the inscription on a monument on the opposite side, it suddenly flashed upon me that she could not read! She was not quite successful in her attempt to conceal this slight defect in her education.

"I think I have a copy of an inscription on a tombstone in Youghal of a Ball who died in 1748. It was taken by a pauper in the poorhouse at Youghal, who amused himself by transcribing it when he had a day out!"

In the autumn of 1896 my father made what he described as "a pilgrimage to visit the tombs of his ancestors." He was accompanied by his wife. He wrote the following account of this tour to his sister (Mrs. Millington):

"*Ilfracombe Hotel* (September 9th, 1896).

"We came here on Saturday, and we greatly like the place. I am, in fact, breathing my native air, for was not dear mother from Somersetshire, and was not our great-great-great-grandfather one of the old Devon worthies? I have been looking up the family. We went to Chudleigh. We found lots of Balls in the registry there, and surviving traditions of Nicholas Ball (b. 1450), whose great-grandson, Thomas Ball, was aged 100 in 1620. We found, in fact, a living specimen in the sexton's wife, who assured us that she was the lineal descendant of the Ball of Mamhead, who lost that splendid estate by gambling.

"We go on Saturday to Bampton, where our said great-great-great-grandfather, Robert Ball, was born on November 20th, 1651. He was an officer in the army of Charles II., and came over to Ireland, and then married Elizabeth Vaughan. I did not realise till lately that the Devonshire estate only finally passed from our family in the time of our great-grandfather, about one hundred years ago. We shall also pay a visit to Mamhead Church on Sunday. It is near Dawlish, a place Aunt Alicia used often to stay at and talk of. If I did not shed tears of sorrow over the bones of my ancestors, I must admit that tears of laughter were not far off!

"F. has been cracking her jokes on the subject in the strain you may imagine. After we had inspected the tombs, and paid our homage to the mighty dead, I ventured, in all humility, to boast of my ancient lineage, and to observe that mine was no mushroom family. Her reply was: 'No; it seems to be a Puff Ball family!'"

It is said that the Nicholas Ball referred to in the above letter had the following epitaph on his tombstone :

"Here lies Nick Ball,
Who had a fall
From grandeur to decay.
His fine estate,
His gold and plate,
All lost was in a day!
' Mamhead ' the stake,
And so he brake,
Now turns he into clay! "

In 1897 a question was raised as to the right of the family to bear arms. My father wrote to Mr. Steele (October 9th, 1897) :

"I have heard that someone who is publishing a book offers splendid coats of arms to anyone who will pay the necessary fees, but I don't see the fun of it. The ' Coats of Arms ' wear to me the form of ' Black Mail '! "

He was led, however, to make inquiry into the matter, and he received a letter from the Ulster King at Arms (April 18th, 1899) :

"I have made a search through the records of this office, and beyond the short pedigree of three generations from Henry Ball, of Youghal (d. 1742), which I showed you when here, and which is connected with the Reid pedigree, there is no pedigree whatever recorded here of your family, and there is no mention whatever of any Arms.

"Evidence that Robert (or Henry) Ball, of Camden House, Devon, was descended from Ball of Chudleigh, or that he was entitled to Arms, has yet to be produced.

"I presume that you can easily claim a Confirmation according to enclosed printed slip, and should you and your brother wish to apply for one, perhaps you would fill up the enclosed form. The Confirmation could be made to you and the descendants of your grandfather; and as regards the difference to be made on the Coat, I would endeavour to meet your views as far as possible.

"I may mention that no Arms are entered to you in the Knights' Register, and I should like to see the blank shield filled up for one of such world-wide reputation in science."

As the necessary evidence was forthcoming, the arms were duly confirmed on April 24th.

A full account of the Devonshire family of Ball will be found in the "Ball Family Records," compiled by the Rev. William Ball Wright, M.A., York (printed by the Yorkshire Printing Company, Limited, 1908). When my father received a copy of this work, he wrote to its author: "Your magnificent volume will make every Ball bounce!"

In the course of his lectures he often had occasion to illustrate the lapse of vast periods of time. This he would sometimes do by referring to the tables of descent, and asking the audience what "a hundred generations" meant to them. In the course of his lecture entitled "The Eternal Stars" he used to propound a question which bore upon the subject. He would say: "I believe most of us do not generally remember much, or even anything, about the personal history of, let us say, our great-grandparents. Do you doubt this? Then let each man in the audience ask himself if he could tell straight off the maiden names of his four great-grandmothers."

The reference to grandmothers also reminds me of what he used to describe as the "theory of grandmothers." "If," he would say, "you trace your lineage back, you will find that you had two grandmothers, four great-grandmothers, and eight great-great-grandmothers, and so on. When you finally arrive at the Garden of Eden, you had *x* great-great-great . . . grandmothers. Eve was one of them. Where were the others?" We were always left wondering.

A few years ago his cousin, the Rev. H. B. Swanzy, M.A., made and sent to him certain extracts from "The Council Book of the Corporation of Youghal" (edited by Mr. R. Caulfield), and from other works. Amongst the extracts were the following:

"1689. Robert Ball, of the Town of Youghal, attainted by King James II., in 1689, as being resident in England (i.e. a refugee).

"*January 24th*, 1687. Robert Ball lent Corporation 10s."

Upon receipt of these notes my father wrote to Mr. Swanzy (September 11th, 1901):

"But now I have to thank you also for the most interesting extracts you have given me. I value them greatly, and I intend to go over them with the portraits in the dining-room, and fix the incidents in my memory. I am so glad one of my ancestors was 'attainted.' There is dignity in that word! It

is also gratifying to know that when the Corporation of Youghal was in deep financial distress an ancestor of mine rose to the occasion and lent them ten shillings!"

* * * * *

Sir Robert's genealogical notes continue:

This much must suffice for my ancestry, but if any curious person desires to know more, I can set down for his information the maiden names of my four great-grandmothers. They were: Jane Meredith, Molly Jones, Mary Ellis, and Mary Croker. I could also give him the names of at least five of my eight great-great-grandmothers!

I would add that any visitor to Cambridge Observatory may see on my walls the pictures of the ancestors whom I have just mentioned, in addition to a good many others. I have also in my possession many Edouart silhouettes of these worthies, including one picture of a great-uncle who fought in the Battle of Bunker's Hill. The following account of him appeared in the *Gentleman's Magazine* for November, 1832:

"Died lately, aged 80, Bent Ball, Esq., formerly captain in the 63rd Regiment, and one of the few surviving officers of the American revolutionary war, in which he received three musket balls in different parts of his body, one of which could never be extracted."

My grandfather, Bob Stawell Ball, had four children, who lived to reach mature age. Of these the eldest was my father. His brother died when I was young, and as "Uncle Bent" was dearly loved by us children. My two aunts, Mary and Anne, were never married.

My father left the ancestral home in Youghal in the year 1827, and came to seek his fortune in Dublin. He was appointed to a clerkship in the Castle, but the office routine was by no means congenial. His every leisure moment was devoted to science and to cultivating the friendship of men who had similar tastes. He made a collection of botanical and zoological specimens,* which formed the nucleus of a large and valuable museum. In 1835 he became a member of the Royal Irish Academy, and of the Geological Society of Dublin, but he may be said to have taken his most important step when he became honorary secretary to the Royal Zoological Society of Ireland, in 1837. "The Zoo" was then in the throes of its

* They are now in Trinity College, Dublin.

early difficulties, and I think it may be fairly said that much of its subsequent prosperity was due to his unstinted and unrewarded labours. In a memoir written shortly after his death, in 1857, Mr. Robert Patterson thus bore testimony to my father's services:

"The hardworking mechanic and the toil-worn clerk will in future years visit the Zoological Gardens with their families as they do now. When enjoying, amid its attractions, the innocent prattle of their children, such men will naturally ask: 'To whom do we mainly owe the existence of this Garden, and the penny admission which makes it available to us?' Let some simple inscription, some unostentatious tablet, answer the inquirer, and tell to him, and to his children, that the name of their benefactor was Robert Ball."

In 1836 my father attended a meeting of the British Association at Bristol. Hospitality of all kinds was shown to the scientific visitors, and it thus came about that my father met Amelia Gresley Hellicar, a lady of good English family, connected on her mother's side with the Gresleys of Drakelow, whose history Mr. Falconer Madan has written so well. This acquaintance led to a happy marriage on September 21st in the following year. The second child and eldest son of this marriage was christened "Robert Stawell," whose reminiscences are to be set down in this volume. In after years a favourable opportunity of alluding to my association with Bristol presented itself. Following the parental example, I attended a meeting of the British Association in that town.

A large party made an excursion to Raglan Castle and Tintern Abbey, where they were hospitably received by Lord and Lady Llangattock. We were entertained at luncheon in the Archery Pavilion, in the Castle grounds. I was called upon to propose a vote of thanks to our host, and I am credited by the local paper with having said something like the following:

"During these little parties friendships are made—friendships which many of us have had reason throughout life to cherish and to esteem very highly. If report be true, on certain occasions even relationships of a peculiarly tender character have been formed in consequence of the opportunities afforded during excursions of the British Association; and if my eyes do not deceive me, similar results will probably ensue on the

present occasion! I am not altogether romancing—far from it. The British Association met twice before in Bristol, the last time about twenty years ago, and the first in some prehistoric period the date of which I do not clearly recollect. In the prehistoric period to which I refer—I believe it was in 1836—there was then, as there is now, great hospitality shown by the citizens of Bristol and the vicinity; and among the visitors on that occasion was a tall Irishman, belonging to section D—the Zoological Department. This Irishman was most hospitably entertained by a family resident in Queen's Square, Bristol, well-known to those present. In this house was a young lady, who was naturally introduced to the young Irishman. The acquaintance speedily ripened into friendship, and I think before the meeting was over the friendship should be described by a still more glowing term. The mutual attachment which thus originated led to the usual happy result. The marriage took place not long afterwards. In due course a son appeared. The child was properly vaccinated, had the measles quite correctly, and all the other natural incidents of childhood. Indeed, to make a long story short, the individual who now addresses you is in this way the offspring of the British Association."

This leads me to a point which may be of interest. I had been described on the previous day as an Irishman, but as my dear mother was a Bristol woman—a thorough Englishwoman—it was obvious that I could not be described as altogether an Irishman. I would like to ask the committee of section A to decide the question! They must take into account that my great-great-great-grandfather came from Devonshire. The problem may be thus stated: If a man's great-great-great-grandfather was an Englishman, and his mother was an Englishwoman, in what proportion do the English and Irish element enter into his constitution? It can be shown mathematically that, if I were divided into thirty-two parts, seventeen of them would be English and fifteen Irish. Such being the proportion, I have to admit, and I do so with much regret, that I am not even half an Irishman.

My eldest sister, Katherine Gresley, dearly loved by all who knew her, was the intimate friend of the late Robert Callwell, of Dublin, and of his wife and daughter. Sir Frederick Burton, late Director of the National Gallery, one of my father's old

friends, made a study of "Kate." The picture is now in the National Gallery, Dublin.

The following sonnet was written by the Rev. R. Percival Graves on August 1st, 1871 :

When in her life I saw that sainted look
By the rare artist's hand of mystery given,
Reflecting in an ecstasy to heaven
The picture of my friend, I scarce could brook
The loss of what I loved. Sure he mistook
Not to have rather caught that sweetest flash
That lights, I said, the darkly drooping lash
Of her soft eyes, unrolling her heart's book
Of sympathy with love, and truth, and good. But now
I thank thee, Burton, for thy work inspired,
The adoring eye, the heaven illumined brow :
Thus stands she in the presence she desired
God loving; loved by God; praying His love
On all she loved below, loves still above.

Kate married Dr. John Todhunter on May 18th, 1870, but only survived for a year.

* * * * *

Thus far the autobiography. My father always cherished affectionate memories of his sisters. When giving away prizes to the girls at a Cambridge school on February 19th, 1900, he said in the course of a speech :

"I once knew a lady who had a remarkable power of attaching to her the love and friendship of those whose love and friendship were best worth having. There can be no harm in speaking of her now, and in speaking of her on this occasion. She died many years before any of the girls in this school were born. She had the power of inspiring affection; and what is no less valuable, the power of retaining it. No boasts would ever have been permitted to issue from her gentle lips, but I think, if she had chosen to boast, she might have uttered words which anyone might have been proud to utter. She might have said: 'I never lost a friend, though few indeed have ever had so many.'

"Not until after her death did a little secret of hers become known. She was one of a long family. She had her many school friends; she had ties by marriage; she had an unusual number of most interesting friends in other ways, and her secret was the scheme by which she kept these friends in

"KATE" BALL

From the drawing by Sir Frederick Burton in the National Gallery of Ireland, Dublin

touch with her. To her, indeed, the words had a special truth:

"'Make channels for the streams of love,
Where they may broadly run,
And love has overflowing streams
To fill them every one.'

We are always told to be systematic in our work, and this dear lady was systematic, not only in the duties of her life, but in her affection for her friends. She counted up those whom she specially wished to cherish—her brothers and sisters, not a few cousins and other relations, her school friends, her other friends—and they numbered twenty-eight. And so she formed a little scheme. One day in each month was assigned to each friend. When there were a few days over, then certain particular friends got two days that month. It might be a visit or a letter. Perhaps it was some little gift; perhaps it was some little attention to the child of the friend. It might even be nothing more than a cutting from a newspaper, or a few kind words on a card, or some message, or even without any actual communication whatever, it might be at least a few kind and sympathetic thoughts. That little calendar of the affections—of which no one knew except the tender heart herself—was indeed twice blessed. It blessed those that received; it blessed her that sent. I ought to know. I was one of the happy twenty-eight. The lady was a beloved sister of my own!"

* * * * *

The autobiography then continues:

My second sister, Mary Agnetta, died in 1868, unmarried, and my two younger sisters were Amelia Charlotte, who married William Millington, M.D., of Old Fallings Hall, Wolverhampton (she died in 1912), and Annie Frances, who married George Butt, of the Bengal Civil Service, in 1875. George Butt died in 1879, and my sister Annie married John Thomson, of Edinburgh, in 1885. She is, happily, still living. My brother, Valentine Ball, C.B., F.R.S., had a distinguished career as a geologist, first in India and then as Professor in Trinity College. In the end he became Director of the Science and Art Museum, Dublin. He died in 1895. My youngest brother is Sir Charles Ball, Bart., F.R.C.S., Regius Professor of Surgery in the University of Dublin.

CHAPTER II

EARLY YEARS*: 1840–1851

I WAS born in Dublin on July 1st, 1840, at No. 3 Granby Row, Rutland Square, a house which had been leased by my father. It was large enough to supply not only the requirements of a rapidly increasing family, but to accommodate his museum and library. The gradual change of social conditions in Dublin has considerably altered the status of houses in Granby Row. I may, perhaps, illustrate this by mentioning how, in recent years, I rather puzzled my dear old mother by asking her if she had heard that the Balls had gone back to 3 Granby Row. "What do you mean, my dear?" said she. I was then forced to explain that I had only the day before passed by and seen at the hall-door three balls (golden balls, however), indicating that a pawnbroker was now in possession of the mansion which had contained us in our infant years. That house had also accommodated innumerable stuffed animals, snakes, tomahawks, and such other articles as in my childish memory I recollect in my father's museum.

My earliest memories of home are intimately associated with the museum and the Zoological Gardens. As secretary of the Dublin Zoo, my father had much to do with all details of the business. In those days, as at present, the council met every Saturday morning for breakfast at the gardens. The chief business of the Society was transacted at these meetings. Thus the council would consider questions relating to the purchase and sale of animals; but during the week the secretary always had power to acquire any new animal that might happen to come into the market. The creatures so purchased frequently found a temporary resting-place in our house for one or more nights, awaiting their conveyance to the gardens, some two miles distant. Nor were these animals always rigorously confined within the limits of their cages. My mother

* This chapter is entirely autobiographical.

used to tell us that she remembered my sister Kate, when quite a small child, running into the parlour to ask her mother to come out and see the lovely little things that were crawling on the stairs. The "lovely little things" proved to be snakes, which had somehow managed to make their escape. A sloth, on one occasion, arrived in the evening, and in order to reproduce the climate of a Brazilian forest as nearly as was possible at such short notice, the sloth was hung on the back of a chair before a fire in the dining-room. I have no doubt the animal passed a very comfortable night. I well recollect how long afterwards we used to point out the marks of its claws and teeth on the back of the chair. As I have since heard, my father held the sloth to be rather a delicate animal. Consequently, it was sent as a present to the Zoological Gardens in Regent's Park, whereupon the council of that Society sent us a young giraffe! I also remember a giant tortoise which sojourned very happily in our kitchen for two or three days. But with the fear of de Rougemont before my eyes, I think it better not to narrate incidents which most certainly happened.*

Among my earlier recollections are those of the scientific men whose intimacy my father enjoyed. The earliest of all these friends was, I think, Mr. William Thompson, of Belfast. He was a distinguished naturalist. He was an authority on the birds of Ireland. His book, in four volumes, "The Natural History of Ireland," which was, I believe, published after his death, contains an immense number of original notes made by his friends, especially my father. He died before my father, and I well remember how deeply his loss was felt. He used frequently to stay at No. 3 Granby Row, and long hours were spent in the private museum, where the two friends discussed the wonderful collection which my father had brought together.

In relation to this collection I may perhaps mention a somewhat curious incident that occurred. Children's parties were occasionally given for our benefit. Among the attractions

* I may properly relate one "incident" of which my father used to tell us. It was that on several occasions he rode round the kitchen on the back of a tortoise. Those who have read Darwin's account of the giant tortoise in the Galapagos Islands, which is to be found in "The Voyage of the *Beagle*," will have little difficulty in believing that the tortoise can be a safe, if not a very rapid beast of burden.

designed for the amusement of the many little friends who thronged the house, were charades, in which my father, with some of his zoological friends, were the chief actors. I remember one charade in which the scene was that of a doctor treating his patient. The patient was represented by no less a person than Isaac Butt, who was then a distinguished Queen's Counsel, and who afterwards became the famous Parliamentary leader of the Home Rule party. Butt was sitting in a chair, and my father was the doctor. The doctor not only prescribed for his patient, but determined to administer the medicine in his own proper person. Retiring into the museum (which was, in fact, our back drawing-room), he picked up a dark bottle which appeared to be empty. One or two assistants were then called in to hold Isaac Butt in the chair, while my father thrust the bottle into his mouth and turned it up as if to administer a dose. Nothing could exceed the brilliance of Isaac Butt's acting! He winced, kicked, and struggled, bringing down the house with thunders of applause! The intense realism of his performance naturally stimulated the doctor in attendance to administer more of what he believed to be an imaginary draught. But it subsequently transpired that the bottle was by no means empty. It had contained snakes in spirit. The snakes had been removed, but a sufficient residuum was left unnoticed in the bottle thus forcibly inserted in the mouth of the unfortunate patient!

I recall another incident of the charades about this time. Rumours of the gorilla were just beginning to reach Great Britain. Fierce as the gorilla may be in actual fact, the real animal was nothing, either in size or appearance, to the terrible beast described in these early reports. At one of our parties Professor Edward Forbes (who, alas! died far too early for his splendid genius to mature itself) appeared decked out in robes to give a scientific lecture on monkeys. He announced that he was privileged to exhibit for the first time in Europe a specimen of the wild and ferocious gorilla from Africa. The museum door was opened, and there emerged, with hideous shrieks, a gorilla about 6 feet 6 inches in height, amidst such a scene of excitement that it was hard to know whether laughter or cries of terror chiefly predominated. My father had manufactured the gorilla head himself. The rest of the costume was made of bear skin. Being six feet five in height, my father

made an admirable lay figure, on which the costume, surmounted by the fearful head, could be displayed. As well as I can remember, Professor Forbes continued the lecture by showing how this remarkable animal could actually be taken to pieces. He first removed the mighty paws, and then the head. For many years afterwards that head remained in the possession of our family, to be used on state occasions for the edification or, more accurately, for the terrorisation of childhood. At last, when my brother Valentine became Director of the Museum in Dublin, it was transferred to the department of Natural History.*

The resources of the museum provided other "properties" of many kinds for such representations. My father had a full Maori dress, in which, according to tradition, he once appeared at a fancy dress ball in Dublin. He had also trumpets of various kinds, blunderbusses, and other such weapons. On one occasion he appeared as a bandit, armed with one of these blunderbusses, which he fired up the drawing-room chimney with a resounding report.

Another friend of the house who often stayed with us was the late Sir Richard Owen. The skulls and bones were then very much in evidence. I remember, as a child, sitting on Owen's lap while he drew pictures of a Bengal tiger in full pursuit of his wretched victim. The successive pictures showed how the victim was approached and finally devoured. I kept up my acquaintance with Sir Richard Owen from those early days of 1848-9 until his death some forty years later.

I have mentioned Professor Edward Forbes in connection with the gorilla incident. He was, I think, a very frequent visitor, and I well remember his long black hair and brilliant, intellectual face. He was an exquisite artist, as those who remember the vignettes in his great book on "British Star-fish" will testify. The evenings he spent with us were passed in scientific discussion. He had the attractive habit of sketching on any scrap of paper lying near, even while engaged in most earnest talk. When he stayed in the house with us my mother always took care to scatter half-sheets of notepaper and pencils on the tables. The pictures which he drew were collected afterwards, and a volume composed of them is still a precious possession in our family. It contains exquisite female faces,

* It is now in the possession of my brother, Sir Charles Ball, Bart.

pictures of Turks in turbans, fairies, and all kinds of little fancy sketches. Sometimes they were humorous pictures. I specially remember one, "Ye Deathe of ye Lady Jane Greye," in which the executioner, armed with a gigantic pair of scissors, is about to snip off the plaintive head, which is held in a convenient position by an assistant grasping the hair.

Of all those who came to our home in those early days, the late Robert Patterson, F.R.S., of Belfast, was the visitor we knew best. He was revered by us all for his kindness to our mother in her widowhood. He was himself a distinguished naturalist. In fact, almost the first of the books of science placed in the hands of school-children in those days was "Patterson's Zoology for Schools." Some of the members of his family inherited their father's taste for natural history; indeed, one of his sons, Sir Robert Lloyd Patterson, eminent in business circles in Belfast, was an observant naturalist. He wrote a well-known book on the "Birds, Fishes and Cetacea of Belfast Lough."

I was only six years old at the time of the Irish Famine in 1846, but I well remember the stories of that time. The total loss of the potato crop was the cause of this famine. I remember that we, as children, were interested to note how the potatoes disappeared from the nursery table, their place being taken by suet dumplings. I also distinctly recollect the terrible fever which followed the disappearance of the famine, and how a very large area near the Royal Canal, on the way to Glasnevin, was occupied by buildings which were known as the "fever sheds" for many years. They were ultimately replaced by a more substantial structure, which now, I believe, forms part of the workhouse of the North Dublin Union.

Then, too, I recollect the rebellion of Smith O'Brien in 1848. There was distinct alarm throughout Dublin. All the windows of our house were provided with stout barricades, and my father, like other householders, had provided ammunition for defence, in case of attack. Indeed, I am not quite sure but that I, a child of eight years old, did not myself prepare some very desperate weapons which I took to bed with me every night, determined to sell my life as dearly as possible.

The first public event that I can remember was the funeral of Daniel O'Connell in 1846. The procession passed down

No. 3 GRANBY ROW, DUBLIN

Sir Robert Ball's Birthplace

Dorset Street, and was visible from our nursery windows at 3 Granby Row.

I remember my little head being thrust out of the nursery window to see it, and how my father said that it couldn't have been Dan after all (he died at Genoa), for the coffin was not long enough, and how I told Cullen, in the stable, what I saw and heard, with the addition that Dan was a very bad man, from which Cullen vigorously dissented!

CHAPTER III

SCHOOLDAYS: 1851–1857

MY father's schooldays are thus described in his own words:

Our education in early years was conducted by a series of governesses. They were very worthy ladies, and I am quite sure they did the best they could, though from the innumerable occasions in which I was in disgrace, I fear I must have been anything but a model child. When I was ten years old I went to a school which was then kept by Dr. John Lardner Burke in North Great George's Street. I was only there for a year, when it was decided that I should be sent to England. My dear mother, herself an Englishwoman, desired that we should be brought up to speak without an Irish accent. With this object in view, we were surrounded from our earliest days by English nurses. It was for the same reason that we boys were sent to English schools. In those days this was one of the arguments used in favour of sending Irish boys to school in England. In later years I used often to laugh at my dear old mother about this part of her policy, and the lamentable failure that it proved to be. For, if I may trust the somewhat frank statements of my friends, and not a few remarks that I have seen in the newspapers, the cordon of English nurses, and the six years which I spent at an English school, were wholly unsuccessful. Indeed, even the fifteen years of my life which I have now spent at Cambridge have not, I am informed, sufficed entirely to remove all traces of an Irish accent!

The school to which I was sent was near Chester, at a little village named Tarvin. My father took me there in 1851. The wiseacres at home used to congratulate me on going to school. They used to say that my schooldays would be the happiest days of my life. I never believed them then, and I certainly do not believe them now. I can frankly say that I hated my

school life. I dare say that this was my fault. My teachers lost no opportunity of impressing the fact upon me.

Nothing could ever induce me to feel the slightest interest in my Latin grammar. In those days Latin and Greek were the only subjects considered to be of the slightest consequence in education. It followed that I was in a state of chronic embroilment with the authorities. The lurid reports which they sent home caused terrible grief to my mother, presaging, as they did, certain discomfiture in this world.

* * * * *

I interrupt the personal narrative at this point in order to show, from contemporary records, that my father's progress at school was not so bad as he would have us believe.

The reports he refers to must have been sent home during the first two years of his school life, for those received by his parents in 1853 were by no means unsatisfactory. Thus, for the half-year ending Midsummer, 1853: *Latin,* "Fair"; *Arithmetic and Mensuration* (Upper Division of school), "Highly satisfactory, average place in class 15, in a class of 87"; *Chemistry,* "Attentive at lectures"; *English Grammar,* and *Composition* and *Dictation,* "Very Good." Dr. Brindley (the head master) appended a note to this report:

"The fact of his standing fifteenth in a school of one hundred and ten boys, ranging in years up to manhood, is alone a proof of his strong reasoning powers, so far as Colenso's Arithmetic is a test of power. I think him a boy of superior mind, and in mildness of character and submissiveness to discipline he daily becomes more satisfactory."

The report for the half-year ending Christmas, 1853, contained the following: *Greek,* "Satisfactory"; *Latin,* "Very Fair"; *Arithmetic and Mensuration,* "Good." (Note added in Dr. Brindley's handwriting: "Extraordinarily good! Eleventh of the whole school.—J. BRINDLEY.") *Conduct, attention, and improvement,* "Highly creditable."—J. BRINDLEY; while in that for the half-year ending Christmas, 1856, the Rev. T. B. Rowe wrote: "Is, on the whole, first in the school in mathematics. His work is always very satisfactory."

* * * * *

To continue the autobiography:

The classes in the school were regulated entirely by pro-

gress in classics, and the boy who was not a classical scholar was generally regarded as an intolerable dunderhead. Things are no doubt better in modern schools. In one respect the utter scorn with which mathematics, or, indeed, any branch of learning other than the classics, was treated was not disadvantageous to me. Two or three hours a week were devoted to such pursuits; but, as the subjects formed no part of the regular curriculum by which class progress was judged, there was no regular course, and it was go-as-you-please or do-nothing-at-all during the hours supposed to be given to these subjects. But let me hasten to do justice to the head master, the Rev. Dr. John Brindley. He invariably employed good assistants. There were always excellent Cambridge men on his staff, and, consequently, if a boy really took an interest in his arithmetic or algebra, there was always a capable and a willing preceptor to direct him. Nor was he retarded if the other boys did not choose to learn, for, as I have said, each was allowed to go as he pleased in these subjects.

I thus had the advantage of acquiring the elements of mathematics, and I feel much indebted to those whose labours afforded me the opportunity. The names of Tatham, Sweeting, and J. Keary come into my mind in this connection; but I must particularly mention my lifelong friend, the Rev. Theophilus B. Rowe. Rowe joined Brindley's establishment shortly before I left. He was six years my senior, and came to the school with the reputation of a Double First at Cambridge. He and I became and remained fast friends. I knew him later on at Bath; and then, when I had sons of my own to send to school, I was glad to place them under his care when he was head master at Tonbridge. When he retired from Tonbridge to enjoy a well-earned rest at Bournemouth, I saw more of him from time to time than I had been able to do during his more active years. Our friendship grew with each succeeding visit, until at last, after a long period of declining health, he passed away.

Before Dr. Brindley commenced his career as a schoolmaster he had become to some extent known as a public debater. He had challenged the Socialist, Robert Owen, to public discussion. His discussions, I believe, attracted some attention at the time, and he always regarded himself as a successful champion of orthodoxy, both religious and political.

What the merits of his services may have been in these matters I really do not know. I remember one large room in Tarvin Hall which was filled with enormous packages containing copies of published editions of Dr. Brindley's letters against Robert Owen. The fact that so large a number of copies remained unsold seems to indicate that the public had made no overwhelming demand for the work!

Of Dr. Brindley himself I would never say or think an unkind word. He and all his family were invariably good to me. Let me give an instance of this. I was always dabbling in experiments of various kinds. Every fifth of November they naturally took the form of fireworks. There was a certain amount of licence allowed in squibs and crackers on Guy Fawkes' Day. In fact, it was observed as a holiday, and Dr. Brindley himself used to appear in the evening with a bundle of rockets. We always had a good supper afterwards. But except on these occasions gunpowder in any shape or form was always strictly prohibited. Personally, I believe this to be a mistake, because boys will get such things, and the danger becomes serious when they commence to try experiments on the sly. Then, from the nature of the case, proper guidance as to how explosives should be used, and as to the precautions to be observed, are not forthcoming. It was in some investigations of this kind that a powder flask burst in my hand on November 5th, 1854. I was seriously injured, and the loss of my hand was threatened. I had acted in clear defiance of all rules, and my action brought trouble on myself and everyone else. Yet no one could have been kinder than Dr. Brindley. I was laid by for many weeks, and I shall bear to my grave very unmistakable scars from this mishap.

Dr. Brindley used to give us excellent moral advice. Many of his precepts about "perseverance," and "sticking to your work when you found any," will not have been forgotten by any of us, but, unfortunately for himself, he sometimes failed to practise the precepts which he was never tired of inculcating. In the result, he was always getting into desperate trouble of one kind or another. Of course, as boys we didn't know all this at the time. But certain incidents in his career were not only not unobserved by us, but were forced upon our attention in a manner that gave us (shall I say?) unfeigned entertainment and delight.

I never knew how he started at Tarvin Hall, but, having taken this fine place, he was extremely energetic in securing pupils. He was also very successful in some of the scholars he turned out. When I arrived there, in 1851, the school numbered something like a hundred boys. There were extensive buildings, schoolrooms, a lecture theatre, and dormitories. Most of these buildings he had put up himself, and he had done so although he had only a short lease of the premises. The lease was to expire in 1852, and had Brindley practised the excellent business precepts he was constantly enjoining upon us, he would, of course, have avoided the *dénouement* which occurred. That which might be expected did, of course, actually happen. When the lease expired the conditions were that Brindley had a flourishing school of a hundred boys, and had enormously enhanced the value of the property by the expenditure of thousands of pounds in building. The landlord, not unnaturally, proposed to raise the rent. There was no talk of compensation for tenant's improvements in those days. Brindley became furious. He vowed that he would throw up the place, and further gave it forth that he would not leave standing a single stone of the buildings which he himself had put up. These preliminary circumstances only became known to us boys in much later years; but what actually happened at the time was quite within our comprehension, and it met with our heartiest sympathy and approval. Just before the close of the last half-year at Tarvin Hall, a crowd which included every able-bodied villager in Tarvin and the surrounding district appeared in the playground with poles, ladders, and various implements of destruction. Brindley himself took the command, and they proceeded forthwith to demolish all the buildings he had put up. Let the fate of the lecture hall suffice. How they got the roof off at first I do not remember, though no doubt I must have been a delighted witness of the scene of destruction. But I do remember distinctly the throwing down of the walls. Billy Astbury (such was the name of Brindley's chief henchman) and his gang of villagers all applied their poles to the wall. Under Brindley's guidance the long poles were applied to the top and the short poles to the bottom. Working all together with a sort of rhythm, they at last got up a swing in the wall. This gradually increased until eventually it went over with a terrific roar and lay prostrate. It was

by means such as this that Tarvin Hall became a ruin, and our days at that establishment were ended.

Before I leave Tarvin Hall, and deal with the subsequent career of Brindley, I may just mention two incidents which come to my memory. The head master announced that he would take some of the boys to see the Great Exhibition of 1851, provided the parents were willing to perform their part. This treat was primarily intended for the big boys, and great was the astonishment and amusement of the school when it was announced that an urchin of eleven years of age was also to be included in the party. Thus my first visit to London came about. I saw the Exhibition. It is but little more now than a memory of the water falling in a crystal fountain, music, and crowds of people. I do, however, recollect a stately figure on horseback being pointed out to us. I shall never forget that I saw the great Duke of Wellington himself. A year or so later I remember being one of the sufferers in a tremendous outbreak of scarlatina. There were sixty boys down, though not, perhaps, all at the same time. It was at this period that old Mr. Addison, Dr. Brindley's secretary, came into our room with the announcement of the death of the Duke.

In more recent years I have occasionally gone to Tarvin to look at my schoolday haunts.

On one such occasion, finding the church open, I wandered into it to see how far I could identify what I saw. There was, it appears, a funeral expected, and there were a few people about. One of these, an aged gentleman, said to me: "This is very sad, is it not?" I told him that my concern there was not with the funeral, of which I knew nothing, but that I had come to the church for the sake of my recollections of the school forty years ago. "Oh," said he, "I was the doctor who attended the sixty boys through the scarlatina." "And I was one of your patients," I replied. It is a remarkable tribute to his skill that there was only one fatality among the whole sixty cases, and that was one of Brindley's own sons. This poor chap had been allowed to take a quiet walk in the sun at the beginning of what was hoped to be his convalescence after a severe attack. But boys are boys. He met with one or two particular friends of his, and they spent the whole afternoon sailing about a horsepond at the bottom of the field, in a tub which it was an especial delight to us to use for this

purpose. He was at last discovered by anxious nurses. They brought him in, drenched to the skin. He was put back to the bed which he was never to leave again.

We were all sent home after the tremendous scene of destruction I have already described, and we did not know what was to be the next step. Dr. Brindley had magnificent energy, and it was presently announced that the school was to be reopened at Abbott's Grange, in Northgate Street, just on the outskirts of Chester. Of course, Brindley was brought to book by his landlord for his conduct at Tarvin, and he commenced Abbott's Grange under a heavy incubus of debt. Nevertheless, his energy was so great, and he was able to point to so many distinguished men who had come from his school (especially my valued friend, Mr. T. B. Sprague, who was a Senior Wrangler), that there was soon a large muster on the school rolls. Before long the numbers reached 120. We were kept strictly confined within bounds, and saw but little of Chester. Sometimes we did get out by dispensing with the formality of asking for permission, which would most certainly have been refused. I spent about four years at Abbott's Grange, being joined there by my younger brother, Valentine. It was at Abbott's Grange, too, that I made a friendship with George Richardson, which was happily preserved as long as his life lasted. He had a distinguished career at the university, and was known and loved for years as second Master of The College, Winchester. It was there, also, I came to know Ernest G. Swift, now the well-known police magistrate in Dublin. At that school also was Mr. Gumbleton, of Queenstown, famous as a horticulturist, Mr. John G. Gibbon, a member of the Irish Bar, and Colonel Wilson, of Tunbridge Wells. I could add the names of about half a dozen more.

The embarrassments of Brindley, though the boys, of course, neither knew nor thought of such things, must have gradually increased. Again another crash came; not, indeed, accompanied by such sensational circumstances as those already narrated, and the school moved to Leamington.

I may here take the opportunity of recounting the closing incidents of Dr. Brindley's career.

It was not long after my brother Valentine and I left Leamington that the school—now for the third and last time—tottered and fell. Brindley had a large family, and he was constrained to

cast about once more for means of livelihood. In the autumn of 1857 my brother and I were staying with my mother's relatives at Bristol, when we saw the town placarded with an announcement to the effect that the great "controversial orator (Dr. Brindley) hereby issues a challenge to any Mormon or Mormons to meet him in public discussion on the — day of ——, 1857." I do not remember the name of the hall. Nowadays such an announcement would be hardly conceivable, but those were the palmy days of Brigham Young. Indeed, it was noised abroad that many people were leaving Bristol for Salt Lake City to join the new sect which was then beginning to flourish. I am afraid my brother and I had no interest whatever in the Mormon question; but from our knowledge of Dr. Brindley, and our personal experience of the strenuous manner in which he conducted his controversies, and, indeed, everything else he was engaged in, we thought that in all probability there would be some good sport at the meeting. Down we went, and found a packed room. A chairman was duly installed, and there were a number of people on the platform. After the usual formalities, Dr. Brindley rose to make his speech. He commenced by a general denunciation of Mormonism, and went on to show, by various lines of argument, the iniquities of polygamy. He then paused, and challenged any Mormon who happened to be present to come and have it out with him then and there on the platform. As the first appeal met with no response, he resumed his argument with greater vehemence than before. This time he showed if not by the Old Testament, at all events by the New, that a plurality of wives was absolutely condemned by the principles of Christianity. Again he paused for a reply. Eventually, after repeated challenges and strong insinuations as to the want of moral courage in the Mormons of Bristol, a figure, tall and gaunt, was seen to rise among the audience. A thin, poor-looking man gradually made his way up the hall and ascended the platform. We were naturally delighted, cheering him heartily in the hopes (which were not altogether disappointed) that we should see some fun. Brindley then attacked the man, principally on the question as to whether a plurality of wives was recognised in the New Testament. Brindley declared it was not; the man feebly asserted that it was. Brindley quoted his texts, and then his opponent quietly produced from his pocket a large black Testament. Everybody

was in a state of tremendous excitement by this time. Dr. Brindley himself was in a condition of acute nervous tension. At last the man found his place, and read out a text in which "wives" was put instead of "wife"! Instantly Brindley shouted, "A forgery! A forgery!" We all applauded vigorously. Dr. Brindley's excitement increased. He said, "I denounce you, sir, as a forger, and I seize that book." Thereupon he rushed across the platform to catch the man. The chairman endeavoured to intervene. The audience got into tremendous confusion, and the meeting ended in a free fight. Who ultimately got the Testament I never knew.

Bradlaugh was then beginning his career, and Brindley fastened on him, with terrible denunciations, up and down the country. Whether Bradlaugh ever met him in discussion, or even replied to him, I do not know. But when Bradlaugh went to America, Brindley started off, intending to follow close upon his heels in order to declaim against the evil which he believed his speeches were doing. It would not have been necessary to mention this had it not been that, while Brindley was so engaged, he was taken ill in New York and died, literally a stranger in a strange land.

This was the end of a man of many merits. He did his best for those committed to his charge, and he and all his family were kindness itself, when the occasion called for it. One of his sons, the Rev. F. Brindley, of Winwick Rectory, Oundle, has been a close, lifelong friend of mine. Another son of his, Mr. C. A. Brindley, is a well-known artist.

CHAPTER IV

COLLEGE DAYS: 1857–1865

AT the end of March, 1857, my brother Valentine and I were inexpressibly distressed by receiving a letter from my mother to say that my dear father was most alarmingly ill. He was struck down on Friday, March 27th, and, though he rallied a little, he passed away on Monday, March 30th. As to the cause of his death, my mother often told us this story. Archbishop Whately, who was a constant visitor at 3 Granby Row, believed much in clairvoyancy. My father, though often invited, refused to attend the séances which were held at the Palace. At length, however, he did go, and upon his return, my mother asked what the clairvoyante had told him. "All rubbish," was the reply. "She says I have an aneurism of the aorta!" He did, in fact, die of a rare form of aneurism (dissecting aneurism), which was totally unsuspected by him or his medical advisers.

The sad news of his death was communicated to us by Dr. Brindley, and on that, as on every other occasion when circumstances really called for it, he was kindness itself. My brother and I were bidden to come home at once to the funeral, and were present when my father was laid to rest in Mount Jerome Cemetery.

The esteem in which he was held is illustrated by the following letter from Sir Richard Owen to my mother (April 2nd, 1857):

"The announcement in your letter, put into my hands just as I was preparing for my concluding lecture, is so wholly unlooked for and so distressing that I can scarce realise it. I have not been more shocked or distressed since the news of poor Forbes's death, and for that we were prepared. But our dear friend—the representative of Edward Forbes in Dublin—gifted with the choicest qualities of head and heart, devoted to every good work by which the social and scientific character of his metropolis and country could be raised—this is no merely

private or personal, but a national loss. And yet his kind, loving and manly heart, so well appreciated by all of us, makes the bereavement felt as if a dear brother had been called away.

"The deepest sympathy will be lastingly felt by both Mrs. Owen and myself for her who best knew the manifold worth of the treasure which has been recalled by Him who gave it."

* * * * *

Leaving his own story for a moment, let me give some account of my father's brilliant university career.

As he himself has shown, he entered college in circumstances which were sufficiently depressing. His father had recently passed away, and his mother was left with very straitened means to provide for a large family. It was in this position of affairs that he began his university life. To gain a sizarship, or a scholarship, was a virtual necessity; but to attain "honours" in Trinity College, Dublin, is by no means within the power of every freshman. I well remember my father telling me how it was only after long and animated discussion, and promises on his part that he would work to the utmost of his power, that his mother could be persuaded to venture the necessary entrance fees. His career in college shows how amply his promise to work was fulfilled. The promise itself was the upshot of a resolution to which he had come in his own mind, to work to the utmost of his ability, to "scorn delights and live laborious days." He once pointed out to me the very spot in Sackville Street on which he formed this momentous resolution.

From a diary kept during his first term as an undergraduate we glean the following facts:

On the day he entered college (October 13th, 1857) he went, in accordance with ancient custom, to breakfast with his tutor, Dr. Ingram. On this occasion fifty-five men presented themselves for entrance. He had not yet made up his mind how to shape his course in life. On October 16th he wrote: "I really think about the ministry of the Lord"; and on October 25th he says: "I went to college chapel for the first time to-day in my academicals. I then came home and wrote, and studied the beginning of St. Luke. After dinner, chapel again; in the evening, more of St. Luke. I begin to think in earnest about the medical profession, but I am afraid it is very hard to get on in."

On December 1st: "I really think I have made up my mind to join the engineering school."

He often told me that, during his later years in college, his working hours were never less than ten. That he had begun to recognise that it was necessary for an undergraduate to set himself regular hours of work is apparent from an entry in the diary on October 27th: "I determined to-day to put down daily the number of hours I work. To begin to-day—9.20."

He passed rapidly from one success to another, always taking a high place in the mathematical classes. On March 8th, 1858, his former head master wrote from Leamington:

"I feel quite ashamed that I have not sooner written to congratulate you on your excellent place at Trinity. I always had confidence in your success—your ability, and steady determined application, must ensure that. Had you remained with us, as others have done, until about nineteen years of age, and been thoroughly prepared, I confidently believe you would have taken the highest mathematical honours either at Dublin or Cambridge. As it is, I feel sure you will be a First Class man, and a good one, too. In the loss of your dear father you have a double motive to excel—to do honour to his much-respected name and to ensure to yourself an honourable competency.

"P.S.—Four nights' discussion last week; three nights' this week with Dr. Bayley, head of the *Swedenborgians!*"

The following memoranda relating to this period occur in his mother's diary:

"1858. On August 6th I went with five children to Weston. Robert joined me in consequence of his having had an offer of a situation in the Post Office, which he declined. In May he passed another examination and obtained second First Honours, and in October he also obtained Honours, when he took the same place and obtained £4 worth of books.

"1859. Robert has made great progress at college during his second year. In the October examinations he obtained the second place in Science and the sixth in Logics. Double First Honours and £8 worth of books. He also wrote a paper on the Gulf Stream,* for which he obtained a prize of £3 10s. from the Philosophical and Literary Society, T.C.D."

His later successes may be thus briefly recorded. After securing several book prizes, he obtained a scholarship, and was made Lloyd Exhibitioner in 1860. In 1861 he was Gold

* See page 188, *post*.

Medallist in Mathematics, First Gold Medallist in Experimental and Natural Sciences, and University Student. In 1863, 1864, and 1865 he was Fellowship Prizeman.

* * * * *

His own account of the early years at Trinity may now be given:

I think it may truthfully be said that I was very industrious during my career in college. This was partly due to the fact that I was only compelled to study subjects which took my fancy. I found the years of undergraduate life the most interesting and important of my whole career. In this respect I suppose my experience is like that of other men. If the amount of interest and excitement in any other four years of a man's existence were proportioned to the standard of college days, he must indeed have led a remarkable life. This can partly be explained by the natural physical development of mind and body which comes about in the few years when a boy is attaining man's estate; but it is also due to freedom from the restraints of school and the pleasure of associating with other minds in the same eager condition as his own. I certainly enjoyed my university life to the full. My opponents in the examination hall were, as is generally the case, my dearest and best friends in social life. Let me mention a few of them. Among my class-fellows I must give the place of honour to Francis A. Tarleton. In the examinations gradually leading up to the Moderatorship we had innumerable struggles, but Tarleton nearly always defeated me. In these contests, indeed, we were both surpassed in mathematics by Burnside, who was afterwards Professor of Mathematics in the University. We were all destined, however, to become "Professors of Trinity." It was, I believe, a unique occurrence in the history of the college—indeed, I never heard of it happening in any other university—that three of the students who appeared in the same class list at the Moderatorship Examination became colleagues as professors in later years. For Tarleton was Professor of Natural Philosophy, and Burnside Professor of Mathematics, when I was Professor of Astronomy.

* * * * *

I break off the personal narrative at this point to insert a letter which I received from Dr. Tarleton, now Vice-Provost of Trinity, Dublin, on August 30th, 1913:

"I have been very much pained to hear of your father's ill-health. I have known him for over fifty-five years, and he is one of the finest characters I ever came across—straightforward, and reliable in the highest degree. He possessed a keen and original intellect, and had great industry and power to work. He was sociable and fond of fun, and of a kind disposition. He was very fond of acting charades, which he did very well. I have often seen him acting at his mother's house.

"Your father, Thomas Little, and myself were the leading mathematical men in our class in college, and got Scholarship in the same year—1860. Your father did not live in college rooms, so I did not see quite so much of him as I did of Burnside and Little; but still, I saw a great deal of him while I was working for Fellowship. Burnside was in the class above us, and dropped into our class, which we thought very hard on us. Your father very kindly asked me frequently to his mother's house, where I saw a great deal of him and his charming sisters."

* * * * *

Perhaps there are few happier moments in a man's life than that in which he hears he has obtained a Scholarship in his University. A Scholarship means much. In the first place, it is a reward obtained after a very strenuous contest with competitors for whose industry and abilities one has the profoundest respect. It means the delight and gratification of the family, and the dignity of a Scholar's gown. In my case it meant the acquisition of material advantages of a very important kind, because a scholar paid no college fees, had an excellent dinner provided for him every day for several years, and had an income of £18 9s. 4d. per annum, which in those days imported much wealth. No subsequent prize or professional success can ever give quite the satisfaction of a Scholarship. On attaining this distinction a man feels his feet under him for the first time, and knows that the abilities of which he cannot help being conscious have received a hall-mark which the world will instantly recognise without question. When I obtained the University Studentship of £100 a year for seven years, in 1861, I do not think it gave me the same satisfaction which the Scholarship had done.

The Studentship, however, placed me in a position of independence, and I was then at leisure to choose what my future career should be. This was a matter of considerable anxiety. Many of my friends urged me to read for a Fellowship in

Trinity. There was nothing at the time I should have liked more than this, but I was by no means sanguine of success. However, I did not see any other clear course open, and thus, after taking my degree in 1861, I commenced this very arduous task.

Forty years ago there were some years in which no Fellowship was granted at all, and there was never more than one. I made the attempt three times. Examinations were held in classics, mathematics, moral philosophy, metaphysics, and in experimental physics; but it is not usual for a man to take more than two of these subjects. My subjects were mathematics and experimental physics. On each occasion I had to encounter Tarleton, my old friend and rival. He proved too strong for me, and after these three attempts I considered it useless to make a further trial. In 1865, still having my Studentship of £100 for another three years, I had to consider what my future course was to be. I first thought of divinity, having known two or three other Fellowship candidates who had had distinguished careers in the Church. Two of them, who were slightly senior to me, I am still able to number among my friends. I refer to Canon Gore, of Chester, and Dr. Meade, afterwards Bishop of Cork. I commenced to attend divinity lectures, and I kept a term under Archdeacon Lee. I must confess, however, that I did not find the study of the controversies concerning the heresies of the Early Church a matter of absorbing interest. It was at this time that I received an invitation, through the medium of my valued friend, Dr. Johnstone Stoney, which diverted me entirely from following the clerical profession. Indeed, it opened up a career for which I believe I was much better suited.

In order to explain why this invitation was of such great importance I must go back a little. Shortly after leaving school I was given a copy of an introduction to astronomy by Mitchell, which is known by the name of "The Orbs of Heaven." I well remember sitting up to the small hours of the morning devouring this book. It delighted me as few books have ever done before or since. At that time I thought the style of the work most fascinating, although I am not now quite sure that my early judgment was correct. But Mitchell's work opened up conceptions which were entirely new to me. From it I learned the difference

SIR ROBERT BALL AT THE AGE OF 26

SIR ROBERT BALL'S FATHER

From a photograph by Magill, of Belfast

SIR ROBERT BALL'S FATHER

From a silhouette by Edouart

between a star and a planet, and other elementary facts. My first lesson in astronomy was thus practically self-taught, for the elements of this subject formed no part of the curriculum in my schooldays. For some time after reading this book I made no further study of astronomy. I had no opportunity then of visiting observatories or using telescopes; and even when at college my attention was at first wholly absorbed by mathematical work. I revelled in conic sections as taught by Dr. Salmon, and geometry as taught by Professor Townsend.

But in the admirable arrangement of subjects in Trinity College everyone is obliged to go through a course of astronomy. At any rate, this was the case in my time. Again, the Honours subjects which I was studying frequently involved the application of mathematics to astronomy. The volume which we chiefly studied was a very beautiful work known as "Brinkley's Astronomy." At the present time I suppose it is entirely unknown to those who study this great subject. But, as I look at it now, it seems to me to be a model of what such a treatise should be, alike in scientific precision and grace of style. I was intensely interested in "Brinkley," and what between that work and "The Orbs of Heaven" I acquired some slight reputation among my fellow-students for acquaintance with these subjects. On one occasion Mr. Barlow, who afterwards became Vice-Provost, was lecturing to us on Mansel's *Prolegomena Logica*—at least, I think that was the work. The expression "planetary perturbations" occurred in some footnote. "Have any of you," said he, "the least idea what is meant by 'planetary perturbations'?" There did happen to be one member of the class who had some notions on the subject, and he felt that his midnight studies of "The Orbs of Heaven" had not been altogether thrown away.

In the later part of my college course, as well as when reading for Fellowship, I was compelled to tackle more formidable astronomical works, such as Newton's "Principia" and Laplace's "Mécanique Céleste." At that time, however, I had no idea of devoting myself to astronomy in after life. It is true that I had leanings towards a scientific career. Indeed, when I was reading for a Fellowship I offered myself as a candidate for the professorship of mathematics at Queen's College, Cork, which had fallen vacant owing to the death of

the great mathematician, Professor Boole. I was not successful, and the fact of my applying would hardly be worth mentioning were it not for the sake of recording the name of my successful rival on that occasion. It was Mr. Robert Romer. After remaining for a few years, he went to the Bar in London, and ultimately became the eminent Lord Justice. I met Sir Robert Romer a few years ago, and reminded him of the fact that he had beaten me thus early in his career. He recollected the incident, and proceeded to tell me something of his experiences at the Irish college. He was at first amazed at the high standard which his mathematical pupils had attained. "On one occasion," he said, "a student brought me a problem which he had been unable to solve. I offered to take it home with me, and talk it over with him on the following morning. What was my astonishment to find that I had to sit up half the night before arriving at the solution. I subsequently found that I had been the victim of a plot amongst the students, who wanted to find out if I was worth my salt. They had selected one of the abstruse problems which had been set in the Fellowship examination in Trinity College!"

Amongst the numerous classes which I attended at college, none were more delightful than those of Richard Townsend, who taught us geometry. His lectures were of a somewhat informal character. Those were not the days of the blackboard. Dispensing with cap and gown, Townsend would sit at the head of his table, having before him a pile of writing material, together with sheets of carbon paper, by means of which he could write several copies of his notes at once. Thus equipped, he would discourse to us upon the geometrical theories of Chasles, the great French geometrician. The lectures often went on long past the ordinary hour. We took such notes as we could, and scrambled for the carbon copies. Even those which bore the least trace of what he had been writing were greatly valued. Becoming enthralled with the beauty of the subject, he would press on at a tremendous speed. The fertility of his mind was such that every theme would gradually unfold under his hand.

The result was that towards the close of each term it would be found that a number of important subjects remained untouched. Consequently, the lectures used to get longer and longer, a climax being reached at the conclusion of the course.

He began at twelve o'clock, and was supposed to end at one. But I remember that on the last day of one term he went on and on, until, when the clock struck two, we were still hard at it. Finally, the clock struck four. This was the hour for chapel, and some of us, who were getting fairly exhausted, made a move as if we wanted to be in time for service. The genial Townsend frustrated us. "Stay where you are, gentlemen," he cried; "I'll tell the Dean to give you all credit for chapel." Having headed us off in this way, we could not leave, and the carbon sheets continued to fly about again until five o'clock, when the dinner-bell rang. (We dined early in those days.)

"Will you give us credit for dinner?" said one of the undergraduates slyly. Townsend himself, dear old fellow that he was, joined us in a roar of laughter, and the lecture and the term came to an end.

If anybody makes inquiry as to my athletic performances in those days, I have to confess that they were almost *nil*. I would hasten to add that, with the single exception of cricket, there were hardly any games. At any rate, this was the case in Trinity College. I believe some hockey was played, but I do not remember any football; and lawn tennis did not make its appearance till nearly twenty years after I left school. I can, however, confess to one distinction as a cricketer. It was generally admitted that I was able to hit higher into the air than anyone else in the college cricket club! I do not remember that anyone else except myself ever had to pay for replacing a window in Nassau Street which had been broken by a ball hit from the College Park!

In those days we were in the habit of taking long rambles on occasional holidays. There was one walk through the environs of Dublin which came to be known as "the as heretofore, so always." Dublin is superbly situated for this kind of recreation. The Three Rock and Two Rock Mountains provide a noble walk within easy reach; and it is not much farther to strike across the military road to Glendalough, or to ascend Djouce or Lugnaquilla. Bicycles had not been invented, so walking exercise was much more extensively cultivated than it is now. I am not at all sure that our glorious tramps over the mountains were not quite as healthy and invigorating as the athletics of the present day. The walk was often varied by

splendid swims in the sea at the Bailey Rocks at Howth, or at Sandycove or Greystones.

A walk along the quays in Dublin was always a source of enjoyment to me in my college days. Indeed, throughout my life I have always taken the greatest delight in ships and shipping. When I was a young man a visit to my mother's relations at Bristol was a frequent event, and, instead of taking the route which involved the shortest sea passage, I always made the direct voyage to Bristol. I made the journey so often that I became very familiar with the officers. The captain of one of the steamers—they were paddle-boats in those days—was a fiery individual who could not brook any delay at starting. Indeed, a crowd often assembled at the North Wall to listen to the torrent of invective which poured down from the bridge. I shall not attempt to reproduce his language. Upon one occasion when I was bound for Bristol, under the care of this famous mariner, I was waiting on the deck, watching the North Wall porters and riverside loafers assisting the crew to load the last remnants of the cargo and luggage. The scheduled time for starting had already been long past, and the captain was raging like a lion up and down the bridge, pronouncing anathema upon all and sundry. Suddenly a groom leading a restive thoroughbred made his appearance on the quay. He insisted on being taken on board with the animal, stating that it was as much as his place was worth to miss the boat, the horse being booked for a race on the following day. Amid a volley of abuse from the bridge we could discern that the captain was willing to take the horse on board if they would look alive about it. Then the trouble began. Nothing would induce the animal to cross the gangway. Coaxing and threats were wholly in vain. As a last resort the donkey-engine was brought into requisition. Sundry large straps having been put round the horse, it was fairly lifted off its feet and dumped on board all in a heap. "Leave go, there!" shouted the captain. The last cable was cast off, and the vessel, moving out into the fairway, headed down the river.

When he had made the horse comfortable, I overheard the groom inquiring of one of the sailors: "When do we reach Holyhead?"

"Begorrah! sir," said the sailor, "ye'll not get to Holyhead by this boat. Shure, we're going to Bristol!"

"Bristol!" said the excited groom. "Shure, I was told it was the Holyhead steamer. Stop her! Let me get back! I'll be all desthroyed if I don't get to Holyhead."

I need hardly add that the plethoric skipper was deaf to all entreaty. To Bristol the groom had to go, together with his horse. How they eventually reached their destination I never knew.

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So ends my father's own account of his college life. His disappointment was that he did not become a Fellow of Trinity; and who shall say that this was not in reality a splendid failure? Set free from the closer trammels of a university, he was at liberty to shape his own career in the world of science.

During his walks he was always on the look-out for things of scientific interest. He wrote in his journal (March 26th, 1864): "I walked to-day with Snip (now Sir Charles Bent Ball, Bart., F.R.C.S.) to Ballinascorney, our first exploration of that neighbourhood. The day was very cold, and we had heavy showers of hail. Snip found no eggs—contrary to his hopes—nor were many plants to be had, members of the Catkin family being those found chiefly. The place has some geological interest. In the valley, excavated, I presume, by the River Dodder, masses of the cliff have been detached and have fallen down. They consist of imperfectly aggregated conglomerate, the pebbles of which are in many cases coated with crystallised carbonate of lime."

He took every opportunity to study botany. On April 5th, 1864, he wrote:

"I have been meditating in my leisure moments on botany, more particularly the distribution of plants. It would be a fine thing to procure a skeleton map of the British Isles, one for each species of plant, and then to collate the local *flora* from all parts of the kingdom, and dot into each map every place where the species has been recorded. The work would be a vastly laborious one, but if completed it would be most valuable. I would propose then to compare these 2,000 maps with the geological features, as well as the contour, etc., and I cannot but think valuable results would follow."

I append certain memoranda which were written by him about this period. They may not be without interest to those who knew him in later life. They show that, at this early age,

he was endeavouring to cultivate systematic habits of thought and gentleness of character.

Early in 1860 he wrote an essay from which I have taken the following passages:

"I find that I am gradually becoming more conscious of the value of time. Hardly a day elapses but something occurs to me which I should like to do, or some subject which I should like to study; but these are all deferred to a more convenient time. I look forward to the vacation as a period when I can study subjects not so immediately connected with my college career as to justify my devoting other time to them. . . .

"The vacation comes and goes! I almost know not how, but I have not done what I want. I have the reputation of being a fairly hard reader, and perhaps this may account for it, as I am confident it is true that the more one desires to know, or the more one knows, the more one sees the immensity that still might be learnt. . . . Scientific studies possess this characteristic in an eminent degree—before we commence in many cases we do not know even what we are going to learn, but as we advance in our subject, new paths for discovery, new fields for observation, crowd upon us on every side. The more we go on, the more endless seems our road; the more we teach ourselves, the more inexhaustible seems the fund of information for our benefit. Take as a simple example the key to all (physical) sciences—mathematics. A person unacquainted with them has no idea of the possibility of such a science. He cannot form the most remote comprehension of its nature. Telling him it is the science of magnitude rather increases than allays his perplexity. He begins to study Euclid, and although he cannot see anything beyond geometry, yet still there is, he perceives, a tolerable variety in geometrical speculation. Algebra and its application to geometry still further increase his view. He then sees that geometrical details are superseded by more refined and comprehensive powers of analysis, but it is not until the mind of Newton stimulates him, when he reads with wonder the sublime investigations of the differential calculus, that he begins to perceive the field of mathematics and to convince himself that he is at the outset of an unlimited yet productive course of study. This position, however, is not to be attained without *work*. There is no denying the fact

that mathematics is the most difficult of the rational, or even physical, sciences, though this latter depends for its very existence on some of the most advanced deductions in mathematics.

"I always had a great dislike for the too common practice of testing scientific theories by the Bible. The Bible was not designed to teach external truths. If it were, every discovery that ever will be made should be contained in it. If it had endeavoured to grasp them it would have failed altogether in its purpose—at least, as far as we can judge of it. Imagine for a moment, had the Apostle Paul, in one of his discourses, told his hearers that by means of steam, men could be conveyed at a rapid rate from one place to another; that there would be an invention whereby knowledge could be conveyed round the whole world in a second of time. If he had promulgated such doctrines as this, his hearers would have said at once that they were false; and if they thought what they themselves were competent to form an opinion on was false, how much more would they have disbelieved the marvellous revelations of Christianity! For this reason the Bible speakers must have accommodated themselves to the natural doctrines then prevalent, and hence it is absurd to test, or to attempt to test, any (not perhaps any, but many) doctrines of physical truth by the Bible. Of course, any speculations which have an infidel or atheistical tendency must be repudiated as contrary to the whole tenor of the Bible. . . ."

He concludes his essay thus:

"I have not sufficiently practised (1) kindness, (2) moderation, (3) gentleness, (4) sufficient thought before speaking, (5) the repression of sarcastic habits. I am sure I could enumerate more defects of character, but since it is not my intention to pen here any terrific regulation with respect to them, I will refrain from so doing. I would only wish that if I am spared till this time twelve months I may be able to look upon this paper, and think, that without incurring the risk of broken resolutions, I have made some improvement on the heads abovementioned."

At the beginning of 1861 he wrote in his diary:

"5.30 A.M. January 24th. Thermometer, F. 15°.

"Here I am at the commencement of the year 1861, and have just read over the paper written by me this time twelve months. I must state that I do not consider I have made

sufficient improvement. Many points on which I had hoped to improve I have too much neglected, and the result is that, so far as the subjects there alluded to are concerned, I feel myself in much the same condition as when I wrote. Still, I must try again, and by more special analysis and stating of what I really want to effect, I think I may be able to lay by valuable maxims for the future. As far as my studies go, I find no cause for complaint. My college career during the past year has been abundantly successful, transcending, in fact, the expectations of my most sanguine moments."

There is an unconscious humour about the following entry, which appears in his diary for January 28th, 1864:

"It is said that the best way of attaining happiness is to look steadily at the worst contingency that can happen, and calculate on that. If this be so, I have come now to look at my ultimate destination—a country curacy!"

He wrote on March 6th, 1864:

"We spent a most pleasant evening at Dr. Stokes's house. The company was but small, but the charades were thoroughly enjoyed both by the performers and audience. I appeared in various characters—first as a doctor examining Dr. Barker and Mr. Carter, next as a rakish divinity student, then as an army officer, but chiefly and most successfully as a scientific lecturer. Mrs. Stokes had designed some ridiculously absurd diagrams of diatoms, and I was asked to lecture upon them! I managed to make a hit, and though many good things occurred to me afterwards which I might have brought forward, had I had more time for preparation, yet I managed to produce impromptu a fair number of strokes."

Nor was he unmindful of his family obligations at this period. When in Belfast he wrote the following letter to his brother Charlie, who was then 14 (August 4th, 1865):

"You are now, I suppose, getting regularly into school life, and I wonder how you like it. Be sure it will be more pleasant after some time than you may think it at first. I am sure you enjoyed your visit to Longford very much. I would have liked to have talked it over with you, but you will not have forgotten it all before we meet at Christmas. I had great fun at Mr. Ogilvy's, riding, fishing, and playing cricket. We were beaten in our match with the other eleven, though we made a pretty good fight of it. I was very successful in swift round-hand bowling in both innings, taking altogether nine wickets, while

not a single run was made off them in the first innings, though one man made a few in the second. In batting I was unlucky, making only 8 and 3. You will, I hope, become a good cricketer. Be sure and write all about it, and tell what time there is for playing, and whether the ground is a good one. I have not seen a single plant down here that I did not know before, but, indeed, there has always been so much going on that I have not searched carefully for them. Yesterday Burnside and I rode to a mountain about seven miles off, put up our horses in a stable, and went up into the heath with two setters to look for grouse. It was beautiful to see them set a bird even 100 yards off, such is the wonderful keenness of their scent, but sometimes they set with the bird just under their nose. We saw about thirty or forty grouse and a few snipe; but the shooting has not yet commenced. When we came back to the farmhouse for our horses we found a repast prepared consisting of about a stone and a half of boiled potatoes, with a proper proportion of milk and butter, and I can assure you we enjoyed it, and also our evening ride home afterwards.

"And now I will just give you one or two words of advice, the value of which I saw myself in six years of boarding-school life. I would have told them to you before you went, but that I had not an opportunity of doing so.

"1st. Never mind anybody laughing at you for what you know to be right. In ten years' time you will forget that you were laughed at, but you will remember with joy that you acted rightly.

"2nd. Never show yourself the least out of temper. If boys at cricket tell you you are out, even when you do not think so, yield at once, and with a smile on your face cheerfully bowl to them. You will find that they will learn to respect you.

"3rd. In any quarrel in any play yield at once, not with a sulky look, but cheerfully and pleasantly.

"4th. Never join a party of boys for the purpose of annoying, even in the smallest matter, any other boy.

"5th. If any boy bullies you (I do not think it likely that anyone will do so, for if you mind what I have said above they will have too much respect for you); but if anyone does, do not call him a 'coward,' a 'dirty bully,' or kick his shins or 'pick up stones, but if he be at all your own size, hit him in the eye with all your might, and you will never be bullied again. If he be much bigger than you, I will advise you what to do. Look out among the biggest and oldest boys the nicest and most gentleman-like and decent fellow, and go to him, even if you have never spoken to him before, and tell him the case quietly. He will advise you what to do, and be pleased at your placing confidence in him.

"Remember this always, that 'Bullies are always cowards.'

"6th. Always speak civilly to every boy. Speak as politely to everyone as you would to Mr. Alcock, and always (when not obviously absurd to do so) with a smile on your countenance.

"7th. Above all things, never associate with any boy who you know has done anything you would not like mamma or me to know.

"8th. Work hard in school hours, play hard out of them.

"That God will help you now and ever is the prayer of

"Your fond brother, ROB."

CHAPTER V

SOCIAL LIFE IN DUBLIN

WHILE he was attending lectures and classes in Trinity, my father continued to live with his mother at No. 3 Granby Row. He wrote the following account of the social life of Dublin at this period:

During the years I was in Trinity College I continued to live with my mother, brothers, and sisters at the old house, No. 3 Granby Row. My father's zoological friends long remained intimate with the family. Mr. Patterson paid us frequent visits from Belfast, while Dr. William Henry Harvey, Professor of Botany in the University, was constantly at the house. Dr. Harvey was then engaged in the task of bringing out his work on the Cape *flora*. I remember visiting his rooms in college. He met me at the door with what I can hardly call a salutation, but at all events with the remark that he couldn't see me, for he was busy writing out his description of three hundred and fifty specimens of groundsel from the Cape!

He frequently visited Youghal in his younger days, and it was there that he first met my father. They used to stroll along the beautiful sea coast for which the neighbourhood of Youghal is famous. It was in these excursions that Harvey laid the foundation of that knowledge which led to the charming volume he published under the title of the "Seaside Book." Later on he secured the friendship of Sir W. J. Hooker, and was then able to gratify his ambition to devote his life to the study of botany. The high official position he obtained at the Cape afforded him a certain amount of leisure to pursue his studies, and he finally returned to England in 1842, laden with botanical treasures. He was then appointed Curator of the Herbarium, at a time when Dr. Allman (whom I have mentioned elsewhere) was Professor of Botany in Trinity College. When Allman was made Professor of Natural History in Edinburgh, the Chair of Botany in Dublin was

given to Harvey. His love of travel for the purpose of enlarging his botanical knowledge was again gratified by a trip on which he started in 1853, spending three years in Australia, New Zealand, and the South Sea Islands. He died in 1866. As with most men of science of his time, who were already in a state of mental maturity, "The Origin of Species" contained doctrines too revolutionary to be readily accepted by him. Indeed, Harvey was so far from accepting Darwin's theory that he delivered an address against it, and this address was printed. Subsequently, however, he came round to Darwin's view, and did his best to call in all the copies of this address, which to the end of his life he sincerely regretted having published. But he never became a real Darwinian. Indeed, I don't think he ever truly grasped what Darwinism meant. In one of his letters to Mr. Asa Gray he wrote: "A good deal of Darwin reads to me like an ingenious dream."

Harvey will be, perhaps, best known to fame at the present day by his *Phycologia Britannica,* which still is, I believe, a standard work on British sea weeds. A very interesting life of him was written by my brother-in-law, Dr. John Todhunter. Harvey belonged to the Society of Friends, with which our family had, in that generation, as I am glad to say they have in the present, many close connections and intimacies. Dr. Harvey, on the botanical side, and my father, on the zoological side, were the life and soul of natural science in Dublin. They founded a society called "The Dublin University Zoological and Botanical Association," of which there were many energetic members.

Let me here mention two. First of all there was my cousin, J. Reay Green, a remarkable, if somewhat erratic, genius. He lived with us in No. 3 Granby Row for years, and I owe much to his intellectual conversation. He commenced his career in a somewhat humble way as an assistant to an apothecary, and his first researches in zoology were made in the beautiful harbour at Kingstown, close to which he resided. He used to collect jelly fish from the steps of the pier. Amongst others I remember the *cydippe* and the *beroë*. He discovered that little was known about these creatures, and even while still quite a youth he identified several new specimens, one of which I recollect he called after Mr. Patterson, *Thaumantias Pattersoni*. These tastes at once brought him

to the favourable notice of my father, and this fact, added to the kinship already mentioned, made him a very intimate friend of our family. Eventually he became assistant secretary to the Zoological Society, and he managed to push himself through Trinity College, Dublin. Before he was of age, there was a vacancy in the Professorship of Biology at Queen's College, Cork. To the astonishment of everyone, he was appointed to this important post. He brought out two books on the "Protozoa" and "Coelenterata." With reference to the latter work, he used to say with delight that he had predicted the existence of a certain type of star-fish, which was afterwards actually discovered. He had an extraordinary memory and a wonderful power of reading up a subject. He had made no special study of botany before he was appointed to be professor at Cork, yet botany was one of the subjects on which he was to lecture! So he therefore began to read it up, and studied with such effect—at all events so far as book knowledge is concerned—that he was able to perform feats that I dare say few expert botanists would be able to accomplish. After twenty years he retired on a pension, and lived for another twenty years the life of a recluse near London. He still read enormously in very miscellaneous directions. In later years his knowledge of Dante was at least equal to the knowledge of Bentham's "British Flora," which he possessed in earlier days.

In my college days the constant intercourse with "Joe Green," as we used to call him, was a most fortunate and beneficial part of my education. My brothers and I were on terms of closest intimacy with him, and I am afraid it must be confessed that we not infrequently enjoyed a good laugh at the expense of our eccentric friend. But his conversation was always stimulating and often entertaining. Never at any moment was it of a commonplace description. He was also wise in counsel. The advice of a man may sometimes be valuable, although he may ignore his own practical application of his precepts.

The last letter I ever had from Joe Green was written in such a peculiar way that I was forced to write to him (on October 7th, 1879):

"I found the pagination of your letter somewhat obscure; yet such is the peculiarity of your style that your letter reads equally well frontways, backways, or mixed!"

With this letter our correspondence came to an end! Joe Green died in 1903.

* * * * *

Upon hearing of the death of his old friend, my father wrote to Mrs. Millington (February 28th, 1903):

"Many thanks for your letter. Yes, poor old Joe is indeed a break with the past! I believe it is more than thirty years since I saw him. I only knew his green plaid trousers by hearsay, for those were the days I was at school, but I have always understood that the pattern of the plaid was emphasised by long streaks of anemone juice, which oozed from the anemones (sea) which he used to carry about in his waistcoat pockets! I learned much from Joe, and cannot hear of his death without some feeling. How we used to goad him in those days! He only lost his temper once in any very outrageous fashion, and then he gave poor Val a sounding box on the ear, which was not, I am sure, undeserved.

"Do you remember how he dismissed his cook at Queenstown because she would not keep the handles of the saucepans turned in the same direction? Do you remember how he entered the athletic field and challenged an officer to a race in Queenstown? All the beauty and fashion in the south of Ireland assembled to see the event, and Joe appeared in green silk tights. He had not run twenty yards before he fell on his nose, and was conducted back to his dressing-room amid roars of laughter.

"What a memory he had! I think he knew every word of Shakespeare, and with what effect could he quote it! When he was receiving an honorary degree in the Queen's University, some friend, seeing the flowing scarlet robes, said to him: 'Halloa, Joe, thou wouldest "the multitudinous seas incarnadine."' 'Go on,' was Joe Green's brilliant retort. If you remember your *Macbeth* you will recall that the next words are 'making the *green* one red.'* Who would have thought that the words 'Go on' could really involve so smart an answer?

"In Joe's early days, as we know, he used to observe Nature, but zoology very soon became for him merely to be studied in book or on paper. His knowledge of botany was, I should think, unique. If he knew the difference between a daisy and a dandelion, when the flowers were before him, it was about the extent of his knowledge. But take him in book knowledge, and he was astonishing. I remember trying him by simply reading from Bentham the description of a plant, and Joe would tell me the name of it, which, considering there are about two thousand plants in the British *flora*, was an astonishing feat,

* *Macbeth*, Act II, Sc. 2, *ad fin.*

especially so when we reflect that he did not know one plant from another when he saw them.

"But he was a good intellectual friend of our youth. I often recall our conversations, and in the intense years of my undergraduate life—1857 to 1861—Joe was a stimulating influence. In long walks by the hour together we would discourse on philosophy and science, though it was occasionally diversified by moments of frivolity. For instance, when passing a spot which I looked at a hundred times since, in the Dunsink days, Joe apostrophised a tree along the Tolka, near Cardiff's Bridge, in the immortal words:

"'Oh, tree, oh, plant, how much of rant
Do bad men talk of thee.
'Tis surely time, in strains divine
To tune my melody!'

"Then, too, much that I learned from Joe has been very serviceable to me not only in my examinations at the time, but ever since. What an extraordinary character he was! I have never seen anyone at all like him. Peace to his ashes!"

* * * * *

My father's notes continue:

Another friend of that time was Dr. E. Percival Wright, who was one of the original "set" which my father gathered round him fifty years ago. For many years he was Professor of Botany in Trinity College. During his life Dr. Wright was one of my staunchest friends.

It will be seen that my young days were passed largely in the company and society of those zoologists and botanists who had gathered round my father. Nor can I ever be too grateful for this circumstance. I attended Dr. Harvey's lectures in botany when little more than a child. Certain of those lectures used to be given at eight o'clock in the morning, in the lovely Botanic Gardens at Glasnevin, and nothing could be more delightful on a bright summer's day than a walk in the early hours to that exquisite spot, along the banks of the Royal Canal. I may mention, in passing, that it is also a place of some literary interest, having been frequented by Addison. It was here that I used to listen to Dr. Harvey discourse on plants, illustrating his lectures from abundant specimens gathered from the gardens around him. David Moore was then the curator of the Botanic Gardens. He was an accomplished botanist, and an authority on the subject of mosses. His place is now filled

by his distinguished son, Sir Frederick Moore. Under him the Dublin Botanical Gardens, so beautiful by reason of their exquisite features, have become a dream of delight to the botanist and to every lover of plants.

In my later years at college I decided to take up botany as one subject for my degree examination. I therefore attended Dr. Harvey's lectures. The knowledge which I there acquired has always been a source of pleasure to me. In the preface to his "British Flora" Bentham tells us how the subject of which he is treating, was to him "a lifelong source of occupation, interest, and happiness." If I may do so respectfully, I would like to echo these words in my own case. My "Bentham" has been my constant fellow-traveller in the British Islands for nearly fifty years. When taking a holiday, there is no joy I more thoroughly appreciate than that which I experience on finding some plant which, as my interleaved copy shows, I have not previously met with.*

And here I may mention that, in my early days, the cult of the fern was at its highest. Everybody had a rockery. Sometimes the rockery was situated in a very disadvantageous place in the heart of a town. My aunts, who then lived in Eccles Street, Dublin, had no garden at the back of their house, but they supplied the want by various devices. Every available window was crowded with pots, while cracked tumblers were used for rearing cuttings. Their cultivation of plants was so successful, even under these difficulties, that one of their impudent nephews was heard to declare that "if Aunt Mary planted a parasol it would soon grow into an umbrella!" They, too, had their rockery. At the back of their house there was a dark, deep yard. In those days every house had a basement, happily unknown in more modern erections. In the depths of their basement my aunts erected a rockery with stones and turf. I well remember that when my father came to see it he was highly entertained at the idea of supposing that anything would grow under such conditions. He called it an "underground Heartichoke." But my aunts knew better, and the ferns did grow wonderfully well.

It was about this time that the Killarney fern—or, to give it its proper name, the *Trichomanes Radicans*—first leaped into fame. Everybody was searching for it. There were, how-

* See Chap. XI, *post, ad fin.*

ever, many places in Ireland besides Killarney where it could be found. Its cultivation became possible owing to the remarkable discovery of Ward, who found that by enclosure in a glass case ferns would flourish under conditions of climate and atmosphere totally foreign to those of their natural *habitat*. I do not remember Ward myself, but my father knew him, and was one of the first to make use of these fern cases. Personally, I never saw the *Trichomanes* growing *in situ*. I have looked for it often in recent years—not later, indeed, than last year (1908)—in County Kerry, but it was not to be found. It was about 1830, or perhaps earlier, that my father found it growing magnificently in an exquisite spot known as Glendyne, on the Blackwater, near Youghal. I have often heard how he was seen running down the glen in the greatest excitement, bearing an enormous handful. This specimen of the *Trichomanes* was duly planted in a "Ward" case, and it flourished exceedingly. It has almost become an established custom for every member of our family to have a Ward case filled with the splendid *Trichomanes*. There is now one at the Observatory at Cambridge, and my brother at 24 Merrion Square, Dublin, is in possession of the great plant which formerly belonged to the late Robert Callwell. Mr. Ward himself declared that though that plant was, of course, growing in captivity, it was probably finer than any that grew wild in nature. When my Aunt Mary died a few years ago, the disposal of the magnificent case of *Trichomanes* which she had, was a question we had to consider. We had no accommodation for it, as our own case was quite large enough. Ultimately it was sent to the College Botanic Gardens in Pembroke Road, where it can now be seen. It bears an inscription stating that it has lived in Dublin houses for seventy years.

There was, indeed, much botanical enthusiasm in Dublin in those days. There was a society known as the "Natural History Society," and I well remember—it must have been about the year 1860—that there was a violent controversy in the papers as to whether one or two species of *Hymenophyllum* were to be found in Ireland. One party declared that there were two species—namely, *H. Wilsoni* and *H. Tunbridgense*—while the opposition party would have it that there was but one species. A leading protagonist in this fight was the

late Mr. William Andrews. He was, I think, the foremost champion of the two-species party. I remember hearing a story something to this effect. It was that, in his younger days, Mr. Andrews was threatened with phthisis. Indeed, it was more than a threat, for the doctors told him that he was incurable. He inquired how long he might expect to live, and they told him about three months. "And does it much matter," said Andrews, "what I do during these three months?" "Not the least," the doctors said. The days of the open-air treatment had not then arrived—or, rather, perhaps, I should say that Andrews anticipated them. "For," said he, "if it doesn't matter what I do, I will certainly go off to the bogs of Kerry and collect the specimens necessary to prove that I am right on the great two-species question." Off he went, got wet through in the bogs every day, triumphantly demonstrated his theory of the *Hymenophyllum*, and then lived for half a century in excellent health!

I have mentioned these zoological and botanical friends, but, as my own tastes lay for the most part in the direction of mathematics, I naturally enjoyed another circle of friends in college. Not that these latter were by any means exclusively mathematicians. One of the truest and kindest friends I ever had, and I am rejoiced to say I still have, is Dr. J. P. Mahaffy,* who was in a class senior to me in college. Another of my friends, then and now, was Mr. Madden. He subsequently represented his University in Parliament, and is now an eminent judge of the High Court in Ireland, and Vice-Chancellor of the University of Dublin. Amongst other friends of those days I may mention (to give them their proper titles) Lord Justice FitzGibbon, Lord Ashbourne, Lord Rathmore, and Sir Thomas Snagge, who, with others, used to assemble year by year at Lord Justice FitzGibbon's famous Christmas party at Howth, County Dublin.

There was a very interesting Literary Society in Dublin which was at its prime when I was a boy. The names of many of its members are well-known in literature and to those who study antiquities. My father belonged to it, and thus, although a boy, I became acquainted with many persons who, for my father's sake, and, I would venture to hope, in some small degree also for my own, were uniformly kind friends to

* Now Provost of Trinity College, Dublin.

me in after life. First let me mention, as a member of this society, Sir Samuel Ferguson. I knew him well, in after years especially, when he was President of the Royal Irish Academy and I had a seat on the Council of that body. Ferguson loved Ireland, her antiquities, and her literature, and was proud of everything that brought honour to her name. We spent many a pleasant evening at his house in North Great George's Street in later years.

One of the Shakespearean evenings at Sir Samuel Ferguson's I particularly remember. The day was January 19th, 1869, and Sir Samuel himself wrote a prologue to the last three acts of *Cymbeline*, which began as follows:

"Ye lovely ladies, and ye men of might,
'Tis *Cymbeline* shall be our play to-night;
But since at large to read the text were long,
Our gentle Shakespeare will forgive the wrong
If in the fore-plot I the piece rehearse
In lines foreshortened and shortcoming verse."

It may perhaps be worth while recording the names of the *Readers* on this occasion:

READERS

Cymbeline	*Dr. Stokes*	Lucius	*Rev. Dr. Salmon*
Cloten	*Professor Ball*	Senator	*Mr. Alfred P. Ferguson*
Posthumus	*Rev. R. Perceval Graves*	Captain	*Mr. John Clarke*
Belarius	*Dr. Ferguson*	Pisanio	*Dr. Ingram*
Guiderius	*Mr. Palmer*	Cornelius	*Rev. J. P. Mahaffy*
Arviragus	*Professor Dowden*	Queen	*Miss Stokes*
Iachimo	*Mr. Thomas Ferguson*	Imogen	*Miss Laura Darley*
		Lady	*Mrs. Mahaffy*

Dr. Stokes, who is here mentioned, was the famous Dublin physician, known by a classical treatise on "Diseases of the Heart and Aorta," and to his contemporaries by his loftiness of thought, and by his intense interest in literature and antiquities.

Another member of this Literary Society was the late Dr. Petrie. He was rather before my time, and, although I remember his imposing figure when discoursing on antiquarian subjects at the Royal Irish Academy, I never had the opportunity of speaking to him. He was an artist and a musician, as well as an antiquary and man of letters. He and Stokes were intimate friends. I have been told that when Stokes' practice as a physician was at its height—his waiting-room being crowded with patients, each with his guinea in readiness

for consultation—Stokes and Petrie would sit over the fire in the consulting-room, chuckling and chatting for hours together, as if there were no business in the world to attend to! We were often at Stokes' house in later years. I frequently had the honour of appearing with him and others in the charades which were got up for the benefit of a very few select friends. It was in his house that I delivered the first lecture I ever gave. When I arrived there on a certain evening, one of the ladies—I think it was Mrs. Mahaffy—told me that they had spent the day in drawing diagrams for a lecture which I was to give. This was the first I heard of it. As to the subject of the lecture, I was to make that out as best I could from the diagrams. At this distance of time I have forgotten what the diagrams were, with one exception. It was a picture of an animal with an unusually large supply of legs, each of these legs being furnished with top boots. Half the legs were designed for walking one way, and the other half the other. However, I struggled through the lecture somehow. In the next scene Dr. Stokes introduced himself as the Rev. Mr. Gooseberry—a curate with £75 a year and eleven children. I forget what my part was, but I do remember that on being introduced to the reverend gentleman I expressed a hope that all the little green gooseberries were quite well. I thus managed to raise a laugh in which even the actor, Dr. Stokes himself, could not refrain from joining!

I can recall names of a few other members of this Literary Society. There was Dr. Todd, a Senior Fellow of Trinity College, Dublin, and author of a Life of St. Patrick; there was Dean Reeves, afterwards Bishop of Down, a most minute scholar and bibliophile; there was Dr. Graves, who was at one time Professor of Mathematics in the University of Dublin. Later in life he was made Bishop of Limerick. He was a skilled decipherer of Ogham inscriptions. With him it was my privilege to be on cordial terms until his death, at a very advanced age, a few years ago.

Finally, there was Dr. Romney Robinson, who always visited the Society whenever his duties as astronomer at Armagh Observatory would permit him to come. He was a man of innumerable gifts of head and heart. To Dr. Romney Robinson it was given to enjoy a span of literary activity greatly in excess of that which falls to the lot of most men. He wrote a poem

on the Battle of Trafalgar, on the day when the news of that victory arrived in England, and he also wrote a monograph on the anemometer which bears his name. The time which elapsed between these two works was seventy-five years, the whole period being one of great intellectual activity! His genius was universal. Perhaps it may sometimes have been felt to be a little formidable. I was told by a lady who was invited to stay at the Observatory, Armagh, that, after breakfast on the first day, Dr. Robinson inquired what particular subject she proposed to study during her visit. The lady hesitated a little, and then said she really felt a great interest in the history of the Moguls, and that she would like to learn something about their dynasties. "Very good," said he. "I will get you the books." After a visit to the library he presently re-appeared with an immense armful of books. Placing them on the table, he said to his guest: "Now I will spend the few hours between this and lunch in giving you a preliminary survey of the subject which is to occupy your attention during your visit with us!"

To me, personally, Romney Robinson was always the kindest of friends. He had known me from my childhood, and always retained the delightful habit of addressing me, both when writing and speaking, by my Christian name.

Romney Robinson was one of the men of truly encyclopædic knowledge. He is, perhaps, best known to science by the anemometer to which I have referred. The latest scientific work of his life involved a series of experiments in Sir Howard Grubb's workshop in Dublin. An anemometer was suspended at the end of a long bar, which could be whirled round in a horizontal plane. By this means an artificial wind of known velocity could be produced. His life was spent in Armagh, where, to a very advanced age, his stately presence was a conspicuous figure even among the great clerical dignitaries in a town which is the seat of the Primate of Ireland.

His learning was often compared with that of Whewell. Various stories told of the one are sometimes repeated of the other. Many of them, no doubt, are true of neither. Robinson was a great orator, and I still recollect, though I was only a boy at the time, a great speech which he made on the occasion when the Royal Irish Academy moved its valuable museum from the confined and limited quarters in which it

had been stored, to a more spacious site elsewhere. He was intimately associated with Trinity College. He had, indeed, been a Fellow of that college, and he returned to Armagh on a college living, supplementing his duties there by being director of the Armagh Observatory.

That observatory, I may remark, had a somewhat unusual history. It was founded by a former Primate, whose name also happened to be Robinson. This Primate had a valuable living in his gift. It was a good living, as such are reckoned, but there were no parishioners, and the Primate thought that he might legitimately obtain consent from the proper authorities, whoever they might be, to apply the emoluments of the living to the sustentation of an observatory for the study of the heavens. Thus was founded an institution which has left its mark on the scientific history of the last century. At the time of the Disestablishment of the Irish Church a clause affording special protection to the observatory was inserted in the Act, so that, although all the ordinary ecclesiastical emoluments of every kind were swept away, subject to a due preservation of the rights of existing incumbents, a special provision was made that the Observatory of Armagh should not be deprived of its resources. After Dr. Robinson's death, my friend, Dr. J. L. E. Dreyer, who had been my chief assistant at Dunsink Observatory, was appointed to the vacancy, and has there carried on important work. To him we are indebted for a great catalogue of nebulæ. He has also written an admirable life of Copernicus, and is the author of many other works.

I have already stated that the Literary Society in Dublin to which I have referred had Romney Robinson as one of its most distinguished members. It has been said of him that, having borrowed "The Lady of the Lake" on the day when that poem was republished, he returned it to his friend the day after, saying that he did not require it any further. Lest admirers of Scott should draw a wrong conclusion from this statement, let me say the reason he returned it was that he could now repeat it from the first line to the last!

When I was an undergraduate I attended a public lecture delivered by Dr. Robinson in the Metropolitan Hall in Dublin. It was a lantern lecture on "Air," and there were many illustrations and experiments. The assistant at the lantern, how-

ever, was not an adept, and when the limelight was first turned on to show some pictures on the screen, the light was miserably poor and ineffective. Those were not the days of high-pressure cylinders. At that time, and, indeed, for long afterwards, the gases were carried about in large bags. These were placed between boards, the gas being expelled by placing weights on the boards. There was one bag for oxygen and one for hydrogen, with pipes leading to the oxyhydrogen jet by which the light was produced. In the belief that there was not sufficient hydrogen, Dr. Robinson's assistant put more weights on the hydrogen bag. As this did not improve matters he put on still more weights. It was really the oxygen which was short, but the assistant did not discover this fact. As he went on increasing the pressure of the hydrogen, and driving more into the blowpipe than could find exit through the jet, the hydrogen forced the oxygen back again along its own tube, and a considerable quantity of hydrogen entered the oxygen bag. The lantern having been given up as a bad job, the lecturer went on to deal with other matters. Shortly afterwards some oxygen was wanted for an experiment. It was the familiar illustration of burning phosphorus in oxygen. A large jar of gas was drawn off from the oxygen bag above referred to, but instead of containing oxygen alone, it contained an explosive mixture of oxygen and hydrogen. Directly the phosphorus was put in, the whole thing exploded with a tremendous report, and bits of glass were driven all over the room. Fortunately, I believe no one was hurt, and afterwards it was realised that we had had a most lucky escape. For if the large bag had become ignited, as well might have been the case in a subsequent experiment, a great casualty in that crowded room could hardly have been avoided.

During my years in college I worked very hard, and my attendances at social functions, or at any kind of evening amusement, were very infrequent. I may, however, recall here one or two of the occasions on which I had, so to speak, a night off. It was announced that Charles Dickens was to read in Dublin. The performance was to take place in the Round Room of the Rotunda. The programme was a triple bill, the pieces to be read being, "Boots at the Holly Tree Inn," "The Poor Traveller," and "Mrs. Gamp." A crowded audience assembled on the occasion. Great was the desire

to see Dickens himself, and great indeed was our astonishment when we did see him. Nowadays, of course, with the help of photographs, the features of every public character are so well known that there can never be much surprise felt by an audience when the man actually makes his appearance. But none of us had ever seen Dickens, and we had not the slightest idea what sort of man would present himself. When, however, he actually did appear, amid a tempest of applause, the result was a great surprise. What we really had expected to see I can hardly say. But we certainly did not expect to see a man whom, if we met him in the streets and did not know, we should certainly have said was the colonel of a crack cavalry regiment. He looked the picture of health. Advancing to his desk on the platform, and holding a manuscript, or what looked like manuscript (at which he hardly ever glanced), in his hand, he began his story. We were overcome by the pathos of "The Poor Traveller." I do not think there was a dry eye in the large hall when he read the great passages about Captain Richard Doubledick. Of the second piece I have no very distinct recollection, but I remember the climax of Mrs. Gamp, when at last she could no longer continue the fiction of the preposterous Mrs. Harris. Dickens, throwing down his manuscript, said in the voice of Betsey Prig: "I don't believe there's no sich a person."

Another memory of about the same period (1860) was a lecture of a different kind. Indeed, it was not even called a lecture. It was described as an "oration" by J. B. Gough, the famous temperance orator. I do not in the least remember how it was I happened to go there; I never attended a temperance lecture before, and have never attended one since, but Gough came to Dublin with a great reputation, and I suppose we went because everybody else was going. I can certainly say that it was the most remarkable piece of declamation I have ever listened to. For the two hours during which the oration lasted even Dickens himself had not a more spellbound audience. Gough was not cooped up behind a desk, with a roll of manuscript in front of him. He was down on the front of the platform, occasionally walking to and fro, and enforcing his points with the most vigorous action. I recollect his description of a shipwreck. He made believe that there was a drowning sailor close to the shore, repre-

sented for this purpose by the edge of the platform. Then he made as if to throw a rope to the sailor. Just before doing so he called out: "Are you a Protestant or a Catholic?" In so acting he desired to show that sectarian differences ought not to be allowed to impede the work of the temperance reformer.

A certain lecture that we once attended has long been a joke in our family. I shall call the man who gave it "Mr. Banter," though that was not his real name. He has long since passed away; but there are doubtless connections of his living who would remember his name, though I am quite sure none of them would remember the lecture to which I refer. I therefore adopt the name of Banter to avoid all risk of giving offence. He was a middle-aged gentleman, who had practically idled away the first half of his life. He then took to working at science and various other things in a very small way. He had all sorts of crazes. It is said that at one time he had dens built in his stable in which to keep lions, but the domestic objections raised to his bringing lions into the establishment were deemed insuperable.

He used to bestow his time with great liberality on scientific men in Dublin, but I am afraid the slight tinctures of knowledge he had obtained were of no use to himself or to anyone else. For slight tinctures they most assuredly were. At one time he wrote a pamphlet about "Armour-plated Ships," which were then beginning to be talked about a great deal, and, small though the intrinsic value of the paper was, he had copies of it bound in the most gorgeous manner possible.

It was with considerable amusement and excitement that we heard that Mr. Banter was to give a lecture on science. I rather fancy he had no very clear idea himself as to what kind of science it was to be; but he was clear on one point: it must be illustrated by experiments. He therefore went round the town and borrowed all sorts of scientific apparatus. He obtained an air-pump, a freezing machine, a coil and batteries, bags of oxygen and hydrogen, two Magdeburg hemispheres, and phosphorus, and goodness knows what else besides. With none of this apparatus was he familiar; I doubt whether he had any idea what he was going to do with it. However, a good audience assembled. A clergyman, well known in Dublin, took the chair, and a valued old friend of ours—the late Dr. G. F. Shaw, afterwards a Senior Fellow of Trinity

College—had a seat in the front row. I rather suspect that he, like ourselves, had come for the purpose of having a good laugh.

The lecture commenced by Mr. Banter reading page after page of the most dismal manuscript possible. To the best of my recollection he told us something like this:

"Air is a mixture of oxygen and nitrogen, and the density of the oxygen is .027945 according to some authorities, or .38957 according to others; there is 29 per cent. of hydrogen as well as carbonic acid, of which the density is .269. Water is also composed of the two gases, and is a *mixogen* of oxygen and nitrogen or hydrogen—I forget which it is—and the densities are the same as they are in the case of the air."

No doubt the figures I have given are altogether wrong, but that is by no means the least faithful part of their resemblance to the original. He continued to read in a monotonous tone for about half an hour. His discourse is well remembered in our family circle by the word "mixogen," which has ever since been the standard expression for anything that is in a hopeless muddle. Dr. Shaw sat it out for about half an hour, and then wrote a message to the lecturer on a scrap of paper. If my memory serves me, the coming Senior Fellow of Trinity College used somewhat forcible language; but the purport of the message was:

"For goodness' sake, stop this awful rubbish."

He then asked someone to go behind the lecturer and slip this communication in front of him. Mr. Banter instantly took the gentle hint, closed his manuscript, and announced: "I shall now show a few experiments." What relation the experiments which he attempted to perform, and could not perform, had to the lecture, did not appear.

In the first place he essayed to show the famous experiment of the Magdeburg hemispheres—how that, when the two hemispheres were placed together and the air exhausted from the interior, they could not be drawn apart. It was rather painful to sit and see him making his preparations, in which he neglected the precautions so obvious to anyone who has ever tried the experiment. When he had finished he declared that the two strongest men in the room could not pull the hemispheres apart. Unfortunately, they fell asunder as he was handing them over to the gentlemen who were to endeavour

to perform the feat of strength. But he smiled on cheerfully, and then tried to explode some mixed gases. He had filled a bladder beforehand with oxygen and hydrogen. As everyone knows, these gases will rapidly exude from a bladder. Without having told us to take the precaution of stopping our ears, the lecturer lit a match, which he attached to the end of a long stick, so that he might apply a light to the bladder from a safe distance. The only result was that the bladder ignobly collapsed! At last he showed something which did succeed. He had a dish of soapsuds, into which he pumped a mixture of oxygen and hydrogen. This produced a quantity of bubbles which certainly did explode when he applied a light. So pleased was he that he then and there repeated the operation half a dozen times. He next proceeded to show the well-known experiment in which the air is exhausted from a cylinder by means of an air pump. If one end of the cylinder is closed with a piece of bladder, the atmospheric pressure should burst the diaphragm. Not being properly dried, the bladder merely sagged down instead of bursting! He then proceeded to scratch it slightly with his knife to facilitate the bursting; but no, even this did not produce any effect! The audience were by this time in convulsions of laughter at the performance, and had become somewhat disorderly. A few of them had even crept up on the platform. While Mr. Banter was labouring at the pump in the hope of producing the desired result, a lively youth got behind him with a walking-stick and pushed it through the top of the bladder. This sufficed to make it burst, amid loud applause from the audience, which the lecturer smilingly accepted as a slight tribute to his experimental skill! He then took another turn or two at blowing bubbles and exploding them. His last endeavour was to illustrate the burning of phosphorus in a jar of oxygen. Somehow or other the jar was upset, and the burning phosphorus ran out on the table. "What shall I do?" he piteously exclaimed to the audience, "for I hear that nothing will extinguish burning phosphorus!" By this time the audience had got entirely out of hand. Even Dr. Shaw, who had preserved his gravity as long as possible, was now in fits of laughter. A number of amateurs made themselves into a volunteer fire brigade and managed to extinguish the phosphorus. Notwithstanding the lecturer's entreaties to be allowed to show the

exploding soap bubbles again, the chairman declared that the lecture was over, and that the money would be returned at the doors. I might add that one of the audience, on being told that he could get his money back, exclaimed: "Money returned! Why, I would pay twice the sum for such a laugh again!"

While I was an undergraduate there was a kind of evening amusement which afforded a great deal of pleasure. I have already alluded to it in speaking of Dr. Stokes—I mean the acting of charades. A great deal of trouble was often taken in preparing the charades, and although nothing approaching the dignity of a written play was attempted, yet much thought was given to the production, and there were many rehearsals, which added greatly to the fun.

The first party of this kind which I recollect was at the house of Mr. Lawson, then Attorney-General for Ireland, and afterwards well known as one of the most distinguished judges who ever sat on the Irish Bench. What the word was I cannot remember, but I recollect one scene in it which was to reproduce the syllable "ling." The curtain rose on the meeting of a scientific society. The President was in the chair, and the minutes were read describing the papers which had been communicated at the previous meeting. I only recollect the titles of one or two of these papers. One of them was:

"On a species of sea-urchin, so vast that its spines were used by the inhabitants of Ancient Samaria as substitutes for spires in their cathedrals."

The next was:

"Professor All-at-sea gave some account of a new process for extracting silver from toasting-forks."

The chairman then called on a learned professor to deliver a lecture on the sea-serpent. Up stood the eminent Attorney-General, Mr. Lawson. He commenced a treatise on the subject of the sea-serpent, which he described to be a living fossil inhabiting immense depths of the earth, and occasionally escaping into the sea. He expatiated on this thing for about half an hour, and then announced that, in order to confirm his theory, he had at immense personal risk and expense undertaken a journey to the home of the sea-serpent, in the hopes of capturing one and bringing it alive to the lecture. These hopes were not realised, but he had succeeded in catching a small

one, which, in consequence of the difficulties of nourishing it with suitable food, had unfortunately died. He had brought it, however, to the meeting. He then proceeded to remove a cloth from the table, which discovered a long thing rolled up. The philosophers of the society crowded eagerly round to gaze upon it. When the string by which it was bound was cut, it unfolded itself as the dried ling, a fish much used in Dublin on fast days. The professor was denounced as an impostor, and the meeting closed with loud shouts of "Ling."

There were many other parties at the same hospitable home, as indeed there were many in other houses. In those days the dinner hour was very much earlier than it is now, five o'clock being the usual time. Even six was considered late. Consequently, charades, with music and a dance now and then, made the long evenings pass happily for the young people.

I knew Father Healy but slightly. I often heard of his famous dinner parties. I remember hearing it said to some Englishmen who had come to Dublin that to know and understand Ireland two things were necessary—one was to hear a speech by Dr. Haughton, and the other was to dine with Father Healy. Speeches by Haughton I have heard by the score, but I never enjoyed one of what Lord Ashbourne called "those wonderful hospitable entertainments" at Father Healy's house. A great variety of guests used to meet at the table of this witty priest. Lord Ashbourne mentions that he dined at the same time with Prince Edward of Saxe-Weimar, Monsignor Persico, Archbishop Walsh, Lord Morris, Chief Baron Palles, Dr. Nedley and others. One servant cooked the dinner and brought it to table. No one could divine how the guests were waited on. The attendance appeared to provide itself in some way or other. It used to be said that on one occasion an officer of the Guards looked round for a servant to take his coat and hat when he entered the house, but the host came forward and said to him: "You know those footmen of mine all gave notice and left on the spot when they heard you were coming!" Father Healy was always ready with an appropriate answer. Thus, when some busybody asked whether a friend of his was a good Catholic, the reply was: "No better man, but a child could beat him at fasting!"

CHAPTER VI

PARSONSTOWN: 1865-1867

AFTER my father left Trinity College, the next few years of his life were spent at Parsonstown, where he was tutor to Lord Rosse's sons. His experiences during this period are thus recorded by himself:

I do not think it had ever occurred to me to embark upon an astronomical career until November 8th, 1865, when I received a letter from Dr. Johnstone Stoney. It conveyed the following message: "Would it be agreeable to you to act as tutor to Lord Rosse's sons at Parsonstown?" I was by no means sure of my qualifications for the post. I had never paid much attention to classics, beyond the small minimum necessary to pass examinations. In those days classics were generally regarded as the primary part of a tutor's duties. Up to that time it had never at any moment entered into my thoughts to become a tutor or a schoolmaster. I may, parenthetically, remark that when Clifton College was founded, I was offered, through Dr. Lloyd, the Provost of Trinity College, the position of chief science master.

Dr. Stoney's letter, however, presented great attractions. When it reached me, Lord Rosse, who had been President of the Royal Society, was one of the most prominent men of science in the kingdom. His great telescope was then, as indeed it still is, unrivalled in dimensions. I saw in this letter an opportunity for studying astronomy under the very best auspices. I also realised that acceptance of this post would enable me to become acquainted with scientific things and with leading men of science. In framing my reply I explained that my classics, to put the thing very mildly, were very shaky, but that I would do my best. I added that with regard to the other matters necessary for the education of three youths of ages varying from eleven to sixteen I had no grave doubts as to my competence, and that I would accept the post, pro-

vided that I was allowed to use the great telescope. A favourable reply was soon forthcoming, in which it was stated that Lord Rosse would be delighted to give me the free run of his Observatory. This decided my course in life, and I have never since regretted for a moment that I failed to become a Fellow of Trinity.

I hasten to say, however, that I did not sever my connection with college without a considerable wrench. I was bound to my *Alma Mater* by many ties, and the acceptance of the new post involved separation from many excellent friends. I did not foresee that nine years later I was to return again to my dear old university—this time in the capacity of professor.

Let me describe the scenes and conditions amongst which my life for the next two interesting years was to be passed. The residence of the Earl of Rosse is at Birr Castle, in King's County, about eighty miles from Dublin. Birr Castle is situated at the little town which was then officially known as "Parsonstown," but to the inhabitants as "Birr." Quite recently I believe the official designation has been abandoned, and the Post Office only recognises "Birr." Birr Castle is a noble building of modern erection, surrounded by a moat. It is situated in a beautiful park, through which two pretty rivers flow, and these unite in a single stream before they leave. The park has also a large artificial lake, ingeniously constructed by Lord Rosse himself, which is the perennial home of innumerable wild duck. Several instances of Lord Rosse's consummate mechanical skill are to be found about the grounds. Visitors used to stand gazing in wonder on a water-wheel which, being turned by the waters from the lake, raised water from a drainage system connected with low-lying lands around. A suspension bridge was thrown across the river close to the castle. The outstanding feature of Birr Castle, by which it will be for ever famous in the annals of science, is the mighty telescope. Between the lake and the castle are two great walls, which are now somewhat overgrown with ivy. I have been told that visitors entering the gates of the park for the first time have driven up to these walls in the belief that they were approaching the castle itself, which is not visible from the park gates. Between these two walls there swings a tube sixty feet long and more than six feet in diameter—a tube large enough to be the funnel of a good-sized steamship. At

the lower end of this tube is the mighty mirror or speculum. Lord Rosse's telescope is what is known as a "reflecting telescope"—a reflecting telescope of the Newtonian type. The instrument is raised by means of a winch, which is placed towards the north, and the observers who are to use the telescope have to make their way to the galleries. It is characteristic of this type of telescope that the eye-piece is at the top of the tube, not, as in the refracting instruments, at the bottom. Four men had to be summoned to assist the observer. One stood at the winch to raise or lower, another at the lower end of the instrument to give it an eastward or westward motion, as directed by the astronomer, while the third had to be ready to move the gallery in and out, in order to keep the observer conveniently placed with regard to the eye-piece. It was the duty of the fourth to look after the lamps and attend to minor matters.

Lord Rosse not only designed the great instrument, but actually constructed it. At the back of the castle he had extensive workshops, where a capable smith named Coghlan and numerous assistants carried out the work under the direction of the Earl himself. It was he who devised methods for getting over the innumerable difficulties involved in casting, grinding, and polishing the great speculum, which weighed over three tons.* He had many failures before he achieved success; and the precepts which he laid down have been followed by all who have since made great reflecting telescopes. To illustrate the thoroughness of his methods, let me recall one detail which I heard from his own lips. In the final polishing of the mirror, rouge was the material employed. When he commenced operations he found that the rouge of commerce was not satisfactory. He therefore investigated the subject, and eventually discovered the way to make good rouge. His method was afterwards adopted in the manufacture of the rouge which is used by the great silversmiths in London.

When I went to Parsonstown, in 1865, Lord Rosse was advanced in years. He no longer took an active part in the work of observation, but he evinced a lively interest in all

* Since these lines were written this great mirror has been removed from the telescope and placed in the Victoria and Albert Museum, South Kensington. The work of removal and transportation involved no small difficulty owing to its weight and fragility.

that went on, and was always glad to think that the telescope was being used.

Lord Oxmantown, Lord Rosse's eldest son, was not one of my pupils. They were his three younger brothers, who are now the Hon. and Rev. Randal Parsons, the Hon. R. C. Parsons—a well-known engineer—while the youngest is the Hon. Sir C. A. Parsons. It has always been a great satisfaction to me to remember that I had the great honour of instilling the elements of algebra and Euclid into the mind of the famous man who has revolutionised the use of steam by his invention of the steam turbine. It would seem that he inherited his father's brilliant mechanical genius, with an enormous increase in its effect on the world.

The two years I spent at Parsonstown were full of interest. Ever since the erection of the great telescope, Lord Rosse had had an astronomer in charge of it. They were five in number, but I only propose to mention three. The first of these was my friend, Dr. George Johnstone Stoney, whom I have already mentioned. He was in Lord Rosse's Observatory in the early days of the great telescope. He did much excellent work, and laid the foundation of a scientific reputation, which was greatly enhanced by his subsequent labours. He left Lord Rosse to become Professor of Natural Philosophy at Queen's College, and was subsequently appointed to succeed my father in Dublin as secretary of the Queen's University. It was then that my friendship with him began, and it lasted until his lamented death in 1911. Although he retired from every official position some time before his death, he devoted his well-earned leisure to strenuous labour in many branches of science. He often found the hours of the day too short for all he wanted to do. Of the many scientific people who work at electricity, physics, acoustics, spectroscopy, and microscopy, there are few who would not gladly acknowledge that Dr. Stoney had often been their teacher.

It was he who began the great work of observing nebulæ with the big telescope. Nebulæ were at that time objects of special interest. At the beginning of the century, Sir William Herschel had completed his famous survey of such nebulous objects as were visible in the northern sky, while Sir John Herschel, in his expedition to the Cape of Good Hope, had

completed the work which had been begun by his father. It was left to the Earl of Rosse to start from the point which these investigators had already reached. His telescope was much more powerful than those which the Herschels had used. Indeed its optical and mechanical arrangements were as perfect as was possible in an instrument of this description. On the other hand, it must be remembered that Birr Castle is not an ideal place for an observatory. It is near to the Bog of Allen. Consequently, the skies were frequently overhung with clouds, to the distraction of the astronomer. Even Herschel himself, in his observatory near Windsor, had found that not more than a hundred hours in the whole year were adapted for the purposes of the highest class of astronomical investigation.

It was fortunate that Lord Rosse had as his associate in those early days one who combined in such a high degree the essential qualities of accuracy and scientific enthusiasm which were found in Dr. Stoney. Dr. Stoney was succeeded at Parsonstown for a short time by his brother, Mr. Bindon Stoney, the eminent engineer, whose great services to the Port of Dublin will be gratefully remembered by every citizen. The Rev. T. Gray, now a distinguished Senior Fellow of Trinity College, was there also, in the capacity of tutor, as was also the late Professor Purser, who was afterwards Professor of Mathematics in Belfast for many years. Purser had left his mark on the science of the time not so much by his own original writings—though even these are noteworthy—as by his great success as a teacher. I think my friend, Professor Sir Joseph Larmor, Secretary of the Royal Society, would gladly admit how much he owed in his early years to the remarkable mathematical teaching which was given in Purser's classes in Belfast.

Such were a few of my predecessors at Parsonstown. I ought here to say that in one respect the position I occupied was somewhat different. For, as already explained, I was both tutor and astronomer. And I certainly had a busy time of it during the two years. The morning was spent with my pupils in the castle. Hours of study over, we indulged in certain rather strenuous forms of relaxation. Felling trees was a favourite amusement of Lord Rosse, and we frequently spent an afternoon so employed. If one desired to fish, there were great pike to be caught in the lake. But the large workshops

were my chief resort during the hours of leisure. I managed to construct a six-inch reflector, having learnt under Lord Rosse's guidance the uses of the screw-cutting lathe and other metal-working tools. Nor did my young pupils confine their energies to the work of the classroom. In those days there was a small workshop just off the library at Birr Castle. This was the constant resort of my youngest pupil, the Hon. Charles Parsons. In this little den he was always making all sorts of machines. I remember two of his early contrivances. One of them was an air cane, and the other a sounding machine, which he afterwards used with success in his father's lake. The depth of water was ascertained by measuring pressure as recorded in a barometric tube, this being, of course, the principle now so well known in Lord Kelvin's sounding machine. With the assistance of his brothers, the future inventor of the steam turbine also made a steam engine, and I well remember the delight they took in grinding the reflector of a telescope in a machine which was driven by the home-made engine.

I asked Lord Rosse for permission to use the telescopes for some private experiments on the moon which I had in contemplation. He warmly entered into the subject. I also got from him *carte blanche* to borrow any books from his library.

On fine evenings I would go to the observatory as soon as it was dark. The observatory proper was a little building containing two small instruments, close under the shadow of the two great instruments outside. One of these was the great reflector already mentioned. The other was the "three-foot instrument"—that is to say, an instrument having a mirror three feet in diameter, the tube of the telescope being ten times as long as the width of the mirror. The great six-foot instrument, however, was the one which we employed for important observations. I shall suppose that we are ready to commence a night's work. The assistants above referred to are already at their posts. Up we climb to the lofty gallery, taking with us a chronometer, our observing book, various eye-pieces, and a lamp. The "working list," as it is called, contains a list of all the nebulæ which we want to observe. A glance at the book and at the chronometer shows which of these is coming into the best position at the time. The necessary instructions are immediately given to the attendants. The observer, stand-

ing at the eye-piece, awaits the appointed moment, and the object comes before him. He carefully scrutinises it to see whether the great telescope can reveal anything which was not discovered by instruments of inferior capacity. A hasty sketch is made in order to record the distinctive features as accurately as possible. One beautiful object having been observed, the telescope is moved back to the meridian to be ready for the next vision of delight. When I first began this work, nothing amazed me so much as the extraordinary speed with which the hours passed. A look at my watch might show it was half-past eight. When I next drew it from my pocket, at what seemed no great interval of time, it would show half-past eleven! On a third occasion I would find it ten minutes to two! I sometimes followed Herschel's strenuous example and remained observing from dusk to dawn. I would have kept this lengthy vigil more frequently had it not been that the faithful and uncomplaining attendants, who could have but little interest in the work, were freezing gradually through the night. Personally I did not mind the cold.* I was young then; indeed, it frequently happened that, after a dinner-party at the castle, I went out with a light coat over my evening clothes to pass the night at the telescope. I should add that work was occasionally interrupted by little visits to the castle, where, by the kindness of Lord Rosse, tea and other refreshments were always available.

At the first glimmer of dawn the order would come for the telescope to be closed up. This operation, which took some little time, having been duly performed, the little party broke up for a well-earned repose.

Lord Oxmantown was also an assiduous observer. Many a night did we spend together at the great telescope. Astronomy was just then beginning to quicken with new life under the great impulse that had been given to it by recent spectroscopic discoveries. A spectroscope (then regarded as of colossal dimensions, for it weighed about seventy

* In later years when he was at Dunsink, he had a buffalo coat with cap and gaiters which baffled the cold during the night in the dome of the South Equatorial. He had purchased the coat, which was made of a genuine skin, in the United States. He used to say that future astronomers would be deprived of such comforts owing to the extinction of the buffalo, and that, notwithstanding the benefits he had derived from the coat, he regretted his small contribution towards the obliteration of this noble animal.

pounds, though that itself would be nothing in comparison with the spectroscopes now used at the Yerkes Observatory) had been built from Lord Rosse's design. By means of it we saw that superb spectacle, certain lines in the spectrum which announced the gaseous character of the Nebula in Orion. With infinite patience Lord Rosse devoted years to making a drawing of the Great Nebula. Those were not the days of astronomical photography. That great advance only became possible when the dry plate was introduced. Lord Rosse's beautiful drawing was engraved on steel by Basire, and copies of it are now to be seen in all the principal observatories. It is an exquisite piece of work. It was repeatedly compared with the actual object in the heavens, and corrected or altered until accuracy was attained. In some respects we may say it is unique. Never before was so much pains bestowed on the drawing of a celestial object, and never again will equal pains be devoted to the same purpose. In an hour or two the photographic plate will now record much more than the most accomplished astronomer can observe, even though his repeated observations cover a period of several years.

The visitors' book at the Parsonstown Observatory contains the names of many great astronomers, both native and foreign. Amongst them I can recall those of Dr. Romney Robinson, who had been intimately associated with Lord Rosse from the first, the late Sir George Stokes, the Astronomer Royal, Sir George Airy, Sir John Herschel, General Sabine, and many more too numerous to mention. I should add that these visitors had been there before my time, for by 1865, when I was in charge, the novelty of the great instrument had to some extent died away.

I would point out that the work of observing in the manner above described is extremely trying and fatiguing. It should be remembered, however, that the nights on which the nicer astronomical observations can be made are few and far between. In the first place, all moonlight nights may be ruled out, for the nebulæ, hard enough to see under the most favourable conditions, become altogether invisible when there is moonlight in the sky. Diligence at the telescope was, therefore, not incompatible with tutorial duties in the day.

I have said that the years I spent at Parsonstown stand out as being of exceptional interest and importance in my life.

I may go yet farther and say that the most remarkable scene I have ever witnessed took place during my sojourn there. Anyone who has apprehended that I was at Parsonstown in 1866 may at once infer that I am now alluding to the great shower of shooting stars. I have described this phenomenon at various times and in many places, but I am always glad to talk about it and think about it, for I wish to preserve as clearly as I can the impression of one of the most wonderful sights that can possibly be seen by mortal man. The conditions were exceptionally favourable, for on the night of November 13th, 1866, the weather was clear and the moon was nowhere to be seen. On that memorable night I had in mind what took place at the British Association earlier in the year. I had then attended a meeting of that body for the first time. For some years a committee of the Association had been diligently collecting information about luminous meteors and kindred phenomena. The annual reports for many years before and after this date are full of information about shooting stars, fire-balls, meteors, and meteorites.

At one meeting some years before, Mr. Glaisher, who divided his interest between meteoric studies and ballooning, had made the startling announcement that, although he was not absolutely certain, there was reason to expect that on November 13th, 1866, there would be a notable shower of shooting stars. His opinion was based upon the fact that such showers had appeared more or less regularly at intervals of thirty-three years. As there had been a display in 1833, it was reasonable to suppose that there would be another in 1866. He made his prediction, as I have said, with some reserve. It was not and could not possibly be made with the confidence which astronomers feel in predicting an eclipse of the sun or moon. Mr. Glaisher's utterance, however, had often been the subject of conversation at Birr Castle, and when we went out to the observatory on the momentous night we had some expectation that the shower would appear. I ought to mention, in passing, that Lord Rosse's great instrument could have been of no use in the observation of a shower of shooting stars. Its movements were too limited and the field was too small. Indeed, with this instrument it was impossible to see as much of the heavens as is occupied by a full moon. A meteoric shower can best be observed either

"with your hands in your pockets," or with a pair of ordinary binoculars, which combine a moderate magnifying power with a very large field of view.

On this memorable evening I had repaired, as usual, to carry on my work at the big telescope. I had observed one nebula. The attendants were occupied in winding the gallery back towards the wall. This operation was necessary to enable the telescope to be moved in order to follow an object which was passing from the meridian by the diurnal motion. I suddenly heard a shout. Looking up, I was just in time to see a brilliant streak of light overhead. It was all that was left of the meteor which had attracted the notice of the attendant and had caused him to shout. Shortly afterwards another appeared, and though they were both brighter than the kind of meteor usually seen, we thought they were only casual visitors. But presently they began to come in twos and threes. It was now about ten o'clock, and Lord Oxmantown had come over from the castle to join me in the gallery. As the shooting stars were every minute increasing in number, we desisted from attempting any further work on the nebulæ, and went up a few feet higher to the summit of one of the great meridian walls from which the telescope was suspended. From a height of sixty feet above the ground I saw a spectacle which, even after an interval of forty years, was the grandest I ever remember having seen. It was a beautifully clear winter's night with the canopy of heaven above us, and not a cloud to obstruct the vision in any direction. At first, as I have said, the great meteors flashed across the sky in twos and threes. Each of them was bright enough and sufficiently conspicuous to arrest attention. But when they came in dozens, in scores, in uncounted hundreds, and finally in myriads, the scene was unspeakably sublime. Not a sound was heard. It was in the dead silence of dark night that the heavens were scored in every direction by these wonderful streaks of light. As a rule, the duration of each was very short—perhaps it lasted a second or two. They were moving, as we afterwards ascertained, with a speed of approximately forty miles per second. Individually they were small objects—probably not so large as the pebbles on a gravel walk—but it was the immense speed at which they were hurrying along which warmed them and converted them into streaks of golden fire. Occasionally

the "streak" did not disappear immediately. In some cases the meteor appeared to leave a sort of phosphorescent haze along its track, which endured for some time. I took note of some streaks which lasted for a quarter of an hour or twenty minutes, becoming gradually twisted and deformed by air currents in the higher atmosphere. This went on until at last the material was dissipated. We were all struck by the fact that the meteors moved in a certain direction. They appeared to radiate from the east. Occasionally they swept round by the north, or by the south; sometimes they streamed right overhead in magnificent arrows of fire; but the point of rising of each one of them was in the east. As the night wore on the eastern sky gradually ascended. In due course the constellation Leo—well known as one of the signs of the Zodiac—attained an altitude at which it could be clearly seen. We then observed that all the meteors had a special relation to the constellation Leo; in fact, they started from that group. Closer examination revealed the fact that there was a certain point in that remarkable sickle-shaped arrangement of stars from which all the meteors appeared to radiate. This point could be determined quite accurately. It is this relation of the shooting stars to Leo which has given them the name of the Leonids.

Lord Rosse, who had come out to the observatory, watched this superb display with me for a couple of hours. In the actual vicinity of Leo itself the track of the shooting star was often very much foreshortened, suggesting a resemblance to a comma on the surface of the heavens. Sometimes the meteor appeared to be end on to us, and then what we saw appeared like a star gradually rising to brilliance, and then again fading to extinction. The explanation is that all these objects were really moving in parallel lines, and that the vanishing point of the parallel lines was the constellation Leo. The stars that appeared to come straight towards us came actually from the vanishing point. There could be no better demonstration of the doctrine of parallel lines than the shooting stars which we saw that night.

Lord Rosse always went to London for the season, and as he took me with him I had opportunities of becoming acquainted with many distinguished men of science. On one occasion we paid a visit to Wheatstone, who was famous not

only in relation to the electric telegraph, but also as the inventor of the concertina and the stereoscope. Wheatstone showed us the original apparatus which he had used in perfecting these inventions. Amongst other curious things he showed us what, for want of a better phrase, I will describe as a negative stereoscope. If one looked at a face through this instrument, instead of appearing to stand out in relief, it appeared to be hollow—just as if one were looking into a mould which had been taken from the face. On another occasion Lord Oxmantown and I went to spend a day with Mr. Babbage, the inventor of the calculating machine.

Other scientific men to whom I was introduced by Lord Rosse were Mr. Warren De la Rue, who had just succeeded in taking photographs of the moon, and Mr. J. P. Gassiot. In his house at Clapham Mr. Gassiot had an immense battery of many thousand cells, by which he could show electrical phenomena in exhausted tubes, which were then novelties in the scientific world.

Lord Rosse also took me to see Sir William Huggins, K.C.B., the late President of the Royal Society. The circumstances under which this visit was paid were of considerable interest, inasmuch as it occurred at a time which was to be memorable in the history of astronomy. Mr. Huggins, as he then was, had recently made his discovery of the gaseous composition of many nebulæ. This was one of the first results of the application of the spectroscope to the study of the heavenly bodies. Let me attempt to describe the nature and significance of the discovery in a few words. In earlier days the view generally held was that nebulæ—those little patches of light on the sky—were only clusters of stars at a distance so great as to render it impossible to distinguish the individual stars. No doubt many of the so-called star clusters can be thus explained; and it frequently happens that objects which look like nebulæ when viewed through a small telescope are found to be star clusters when telescopes of great power are directed towards them. The spectrum of a star, properly so-called, has a general resemblance to the solar spectrum. It exhibits all the colours of the rainbow, and forms a brilliantly coloured streak of light. But it is well known that when a gaseous object is examined through a spectroscope the light, instead of being drawn out into a long, variously coloured

streak, is concentrated into one or more bright lines, with intervening dark spaces.

One evening Huggins turned his spectroscope, which he had already wielded with such admirable effect upon the stars, towards one of these nebulæ. He has stated that he himself was astonished at the result. At first he thought that the instrument must have become deranged, because he failed to find the streak of light which a star ought to show. Instead of a streak, he saw nothing but a line in which the light seemed all concentrated. Closer examination showed that the light coming from the nebula was entirely contained in two or three lines, from which, knowing the properties revealed by ordinary gases when examined by the spectroscope, he drew the inference that the celestial body under observation was of a gaseous nature. It is impossible to overestimate the significance of this discovery. The theory then accepted with regard to nebulæ had taught the world that the sun and the planets had all been evolved from a nebula in some form. But this theory had theretofore been open to the objection that, so far as we knew, no such nebulæ existed in the universe. The discovery made by Huggins that night silenced this objection for ever. It showed that gaseous nebulæ were of common occurrence in the heavens. This was the commencement of a most remarkable series of investigations, prosecuted with great vigour by Huggins himself, and afterwards carried on by other astronomers in various parts of the world.

I visited this renowned astronomer shortly after he had made his great discovery, and the occasion was made still more interesting by another circumstance which I shall now relate. Tuam, in the West of Ireland, is a place remote from the ordinary scientific centres, but in that town there dwelt a very acute observer of the skies, the late Mr. Birmingham. I do not think he ever used a telescope of high power. No doubt he had a fairly good instrument, but he had something else, without which the most admirable instruments are of little use—he had genuine interest in his subject. He also possessed that accuracy and care which are so necessary in faithfully recording observations. One evening Mr. Birmingham noticed a bright star in a place where he did not remember having seen any point of light before. He immediately consulted a map of the heavens. This confirmed his

recollection. There was no star marked in the place indicated. He knew that it could not be a planet, as the whereabouts of every planet is regularly set forth in our almanacs. They are always to be found in their proper places. It seemed that the Tuam astronomer had discovered the birth of an entirely new celestial object. He wrote two letters, one to the *Times*, and the other to Mr. Huggins. As he had not been heard of before in scientific circles, those who were first told of his discovery came to the conclusion that he was mistaken. It did not seem likely that an event of this kind should have passed unnoticed at recognised observatories by all the well-known astronomers, only to be detected by a comparatively unknown astronomer in a rather remote part of the country. Mr. Huggins, however, thought that there could be no harm in looking towards the spot in the heavens which Mr. Birmingham's letter had clearly defined. There he found the star blazing brilliantly. He then remembered his spectroscope, and, turning this instrument upon the star, he made a startling discovery. I have already pointed out that the spectrum of an ordinary star is a long streak of light, coloured from one end to the other with the hues of the rainbow. In the spectrum of this new star, which astronomers now know as τ Coronæ, because it is in the constellation of Corona, the streak was not, indeed, wanting; but superimposed upon it there were certain brilliant lines. Even if Mr. Huggins had known nothing of the wonderful history of the object he was studying, he would have immediately pronounced it to be a celestial body of unusual character. He would have been led to this conclusion solely by his spectroscopic observations, for there was nothing in the appearance of the star to attract special attention as distinguished from other stars. Indeed, if it had presented any unusual appearance, it could scarcely have escaped the vigilance of astronomers and observers other than Mr. Birmingham. It was fortunate that Huggins had so far perfected the spectroscope as to be able to deal with the new object. Indeed, it could not have arrived more opportunely if the highest interest of science had to be served.

His spectroscope taught Huggins that there were in the new star great volumes of gas. The gas consisted to a large extent of hydrogen, which was at the moment in a state of blazing incandescence. The discovery of this fact threw a flood

of light on the remarkable suddenness with which the star had appeared. It is generally thought that there had been a collision of two stars hurrying along through space with stupendous velocity. The effect of the impact was to generate heat sufficient to vaporise the solid constituents of both stars.

It was shortly after these startling discoveries that I paid my visit to Mr. Huggins. The evening was bright and clear. The great astronomer lived then in Upper Tulse Hill, and those who say that the climate of England is unsuitable for delicate astronomical work should bear in mind that at least one great modern astronomer made some immortal discoveries in a sky which is often obscured by the fog and smoke of the great metropolis. Huggins had a dome at the back of his house, which contained his telescope. On the occasion of my visit I met Dr. Miller, the distinguished chemist, who had been closely associated with Huggins in his spectroscopic work. Miller had helped to measure the dark lines in the spectra of other stars, which work he had carried on with the utmost delicacy of skill and completeness. So admirable was the work as done by the astronomer and chemist in association, that each received the gold medal of the Astronomical Society for his share in the work.

On the night we visited Mr. Huggins, Mr. Birmingham's new star had lost something of its pristine splendour. It had sunk to the sixth magnitude, and was no longer visible to the naked eye. But when we entered the dome we found both the telescope and the spectroscope turned upon it. Huggins first took us outside, where, by means of a pair of binoculars, we could see the wonderful object which had declined so much in lustre in the course of a few days. He then showed it to us through the spectroscope. The bright lines were quite unmistakable, although no doubt they were fainter than they had formerly been. It was thus that we saw in all its grandeur this wonderful light which was kindled in the depths of the heavens. I have since seen other phenomena of a similar nature, but nothing can ever displace from my memory the evening at Tulse Hill to which I now refer. The delight of making the acquaintance of Mr. Huggins himself, the novelty of the spectroscope—that little instrument which, attached to the eye-piece of the telescope, is so potent an agent for analysing the wonders of the heavens—the beauty of the subject,

and, last but not least, the reflection that this was probably the beginning of a new era in celestial investigations; all these made the visit an incident in my life never to be forgotten.

Among the visitors at Birr I should have mentioned Dr. Brünnow, who was appointed Astronomer Royal of Ireland in succession to Sir William Rowan Hamilton, who died in 1865. I little thought when I first met Dr. Brünnow at Parsonstown that I was to take his place at Dunsink a few years later.

I will conclude what I have to say about my sojourn with Lord Rosse by stating that shortly after I went to the Royal College of Science, Lord Rosse fell into bad health, and after a severe operation, from which he never rallied, he died on October 30th, 1867.

* * * * *

Dr. Dreyer, of the Armagh Observatory, has been kind enough to supplement my father's own account of his work at Parsonstown with the following:

"Ball went to Parsonstown, probably in January, 1866, to prepare Lord Rosse's three younger sons for Trinity College, Dublin, and also to observe with the great telescope. Though the teaching was considered his principal work, he was chiefly induced to accept the post (as he said in after years) by the prospect of studying the heavens by means of the six-foot and three-foot reflectors, of which the former was at that time still *facile princeps* among telescopes. Erected in 1845, it had been used more or less continuously since 1848 for observations of nebulæ, the great discovery of spiral nebulæ having been made with it, almost as soon as it was first pointed to the sky. When Ball began to use it in February, 1866, nearly all the large and interesting objects had been carefully drawn, and there was very little left to be done in that direction. But the micrometer had been very little used, and he found there a field worth cultivating. As the telescope was not yet provided with a clock motion to counteract the earth's rotation, it had to be moved along by hand by a workman, while the observer took measures of the distance and position angle between nebulæ near each other, or a nebula and several stars close to it. Obviously, measures taken in this way could not be very accurate; still they might be of use in various ways, and it was therefore desirable to make them as carefully as possible. The telescope was not mounted equatorially, but was supported at

the lower end on a universal joint, with its primary axis directed east and west. As soon as the telescope was moved away from the meridian its optical axis therefore began to describe an arc of a great circle through the east and west points of the horizon, while an equatorial moves along a circle parallel to the equator. The zero-point of the position circle of the micrometer was therefore continually altering, and a correction ought to be applied to the angles measured. This had never yet been done, and as the correction depends partly on the distance of the telescope from the meridian, and the time had never been noted when the measures made by the earlier observers were taken, it had not been possible to apply the correction to them. It was an easy matter for Ball to find a formula by which this correction could be worked out, and from that time it was always applied.

"Another improvement which Ball tried to introduce in the work of the observatory was the collation of the observations already made, with a view to finding which objects did not require any further attention, as a great deal of time had been wasted for some years previous to his arrival by indiscriminate observing. But he did not remain long enough at Birr Castle to effect much in this way.

"He was an indefatigable observer, and was remembered for years after his departure by the workmen who helped to work the telescope as the man who kept them up 'terrible late' at night. And yet Lord Rosse said that no matter how late he observed, he turned up at the castle the next morning to attend to his work as tutor with almost his usual punctuality. He lived in rooms in Cumberland Square, Parsonstown, about eight or ten minutes' walk from the castle and the telescope.

"His last recorded observations were made in August, 1867, just before he was appointed a professor in the Royal College of Science, Dublin. His observations were published in 1879-80, with the rest of the long series of observations of nebulæ made with the great telescope from 1848 to 1878."

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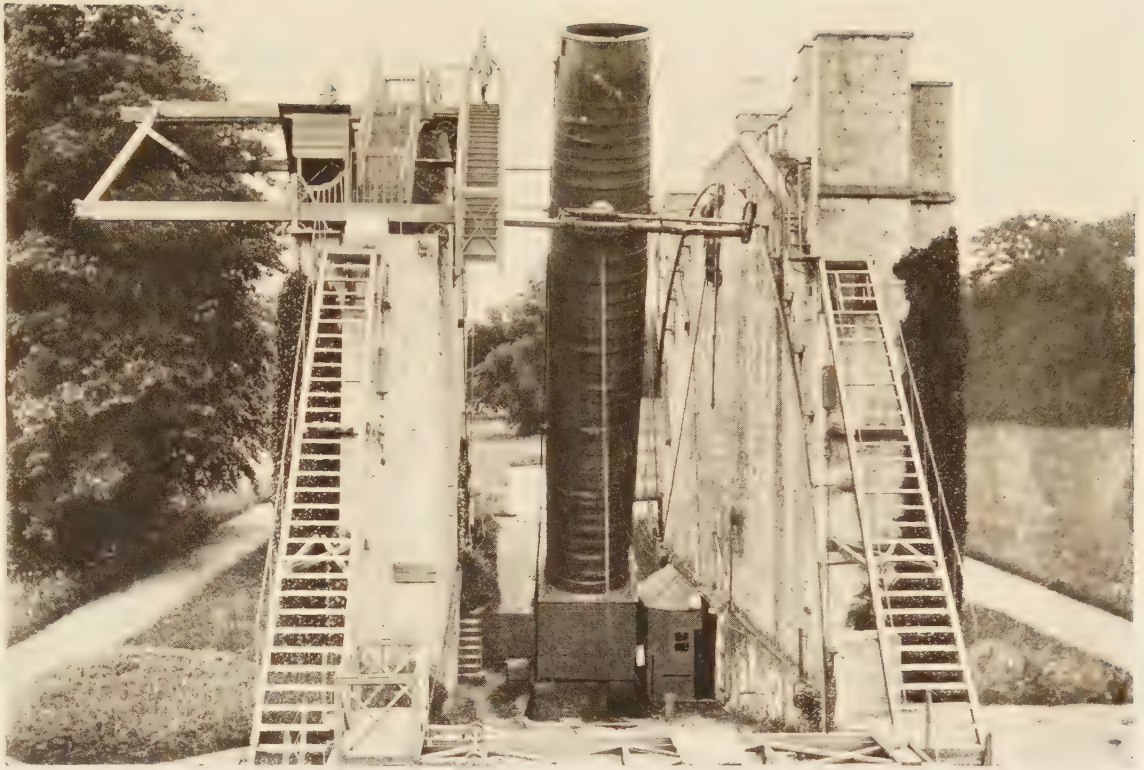
My father never forgot his pupils at Parsonstown. He retained their friendship to the end, and they frequently consulted him on scientific matters. Sir Charles Parsons wrote to him on October 9th, 1899:



Photograph by E. Morrison, Birr

LORD ROSSE'S TELESCOPE AT BIRR CASTLE

"I have on hand an address to the Senior Engineers next month on heat engines, and should be very much obliged if you can tell me if I am right in taking approximately 2,000,000,000 as the fraction of the sun's total heat radiated that is caught by the earth. Is one right in taking it as the ratio of the solid angle subtended at the sun to the whole spherical angle? Also what depth of ice is it calculated that the sun's direct heat would thaw in twelve months, say in Egypt? Pray excuse my ignorance, but one gets so very rusty when immersed in ordinary engineering surroundings."

My father's reply is not recorded, but Sir Charles wrote again on October 21st:

"It is exceedingly kind of you to write me so fully, and it is just what I wanted.

"My address is on heat engines, and I wanted to show that with mirrors it would be quite possible (I think financially) to generate steam power in Egypt or the Sahara, allowing 50 per cent. loss to cover absorption and loss in reflection. A 13-foot diameter mirror ought to generate 1 h.p. for twelve hours a day on the average. I will send you a copy, if it gets printed, as they usually are, but possibly it may be too bad for this privilege. Very many thanks, and with best wishes.

"P.S.—A 24-inch diameter short-focus mirror, as used for searchlights, will work a toy engine very well.

"P.P.S.—Mr. T. Lipton has got his yacht too short and full-bodied for the speeds they go. They seem to design by rule of thumb in England—they should rely on model experiments, which would put them right."

CHAPTER VII

THE ROYAL COLLEGE OF SCIENCE: 1867–1874

THAT my father did not waste the two years which he spent at Parsonstown is shown by the fact that, when the opportunity offered, he was ready and willing to undertake work in a wider sphere. He was primarily a mathematician, but always a teacher: one of those who could really impart knowledge to others; while he had also the admirable faculty so indispensable to the teacher of being able to inspire enthusiasm.

An account of his activities during the seven years after he left Lord Rosse may be given in his own words.:

I was destined to spend only two years with Lord Rosse. In 1867 the Government of Ireland founded a new institution under the Science and Art Department. It was called "The Royal College of Science," and was for the purpose of providing thorough instruction in science for those who were willing to undergo a three years' course. Among the officers to be appointed was a Professor of Applied Mathematics and Mechanism. During my years in college I had devoted much attention to theoretical mechanics, while the many pleasant hours I had passed in Lord Rosse's workshops had given me some insight into practical mechanics and mechanism. I received a letter from my valued friend, Dr. Haughton, in which he told me that he had had a hint from a well-informed source that, if I offered myself as a candidate for the post, and if Lord Rosse would support my application, I should probably be appointed. I suppose it was lest I should feel too exalted by this communication that he commenced his letter by saying: "I hear there is a dearth of candidates of merit for the new professorship in the Royal College of Science. It is worth £400 a year, to increase to £500, and better than any Queen's College professorship." The post of a professor presented itself to me as a considerable advance on my position. Lord Rosse wrote to support me in the kindest and strongest way, and my

application was successful. It was thus that I left Parsonstown—not, indeed, without much regret at parting from the friends who had been so kind to me—and took up my position in Dublin.

In order to stimulate public interest in the college, and to make it known among the citizens of Dublin, who were hardly aware of its existence, we announced a special course of evening lectures at a nominal rate. These lectures were addressed to working men. Each of the professors who participated in the scheme was to lecture six times on his own subject, the fee to be paid for the course being the large sum of sixpence.

It fell to my lot to deliver a course on mechanics. My kind friend, whom I have so often mentioned, Dr. Johnstone Stoney, called my attention to a remarkable book by Professor Willis, entitled "A System of Apparatus for the Use of Lecturers and Experimenters in Natural Philosophy." As soon as I became acquainted with Willis's apparatus I was surprised to find that it was not in more general use. It consisted of a multitude of parts—pulleys, gear wheels, etc., not mere toys or playthings, but actual machines or parts of machines which, by means of a suitable framework, could be built up into the most protean shapes. It was possible to fashion a model crane and many other machines with moving parts with this apparatus.

In giving my lectures I made use of Willis's apparatus, with a few home-made additions. This enabled me to illustrate my points by experiments on a large scale. Perhaps this apparatus would hardly call for mention in these reminiscences were it not that, as will subsequently appear, it played a somewhat important part in my future career.*

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My brother Robert S. Ball writes as follows concerning the Willis apparatus:

"My father thus laid a deep and solid foundation for the teaching of mechanics by systematic experiment. He often acknowledged his indebtedness to Mr. Willis, who devised the extremely ingenious apparatus with which he demonstrated mechanical principles at the Royal College of Science. Professor John Perry, D.Sc., F.R.S., in the preface to his excellent

* See Chap. X., p. 189 *post.*

book on applied mechanics, refers to my father's work. He says (*inter alia*) : ' Professor (now Sir Robert) Ball, at the Royal College of Science, Dublin, started quantitative experimental mechanical work. He used the well-known frame of the late Professor Willis, which was taken to pieces and built up in new forms for fresh experiments. What I have done has been to carry out Professor Ball's idea, using a distinct piece of apparatus for each fresh kind of experiment. A student measures things for himself; illustrates mechanical principles; finds the limits to which the notions of the books as to friction and properties of materials are correct; learns the use of squared paper and the accuracy of graphical methods of calculation; and, above all, really learns to think for himself.' The important work done by Professor Perry is too well known among students of mechanics and engineering to require emphasis here, and that my father was one of the first to make use of a method now so admirably developed by Professor Perry and others shows alike his power as a teacher and a capacity for interesting his students. In a letter to me, dated January 7th, 1915, Professor Perry writes :

"' There were teachers of mechanics before your father who made quantitative experiments before their pupils. I did so myself at Clifton College in 1871. But he developed the thing into a system. It was about 1871 or 1872 that my brother James (late County Surveyor of Galway) told me of his own experimental work under your father at Dublin. It was because it was systematic and not casual; because my brother told me of how it caught on with students who were incapable of abstract reasoning; it was because I saw that here was a brand new thing of enormous value that I took it up.' "

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In 1868, the second year of my life at the College of Science, I married. My wife had been well known to me since childhood. She was Frances Elizabeth Steele, daughter of Dr. William E. Steele, one of my father's old friends. Dr. Steele was at that time Registrar of the Royal Dublin Society; later on he became Director of the National Museum in Dublin, under the Science and Art Department.

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I venture to interrupt his personal narrative by a letter which my father wrote to his mother when on his honeymoon :

"HOTEL GLENDALOUGH,
"CONNEMARA.

"We were told that we would find a 'passable' hotel here, and so we have; and I would recommend other tourists likewise to consider it pass(by)able and not think of seeking accommodation in it!

"The day is pouring wet, so we have not been able to explore the beauties of the region. We are prettily situated on the margin of a fine lake, and behind us are some of the finest mountains in Connemara; and if we find it possible to stay here for a few days, we shall do so with profit and pleasure.

"The resources of the establishment are unique. There is *one* towel—or rather a part of one—and F. and I have bespoke the first use thereof to-morrow morning. We had a little butter with our potatoes at dinner, and at tea a pile of toast appeared with a scrape of butter on the two top slices. On our asking for more, we were apologetically informed none was to be had. It is the most awfully wild and unfrequented region; there is not a human being to be seen—not even a priest. The 'hotel' seems to be owned and managed by a lad of sixteen, with the invaluable assistance of two small boys. Tell Aunt Anne I hope to bring her some good roots of the Connemara heath, which grows plentifully all about the neighbourhood. F. and I both agree that the statement about a honeymoon being a great sell is *abominably false!* With dismal rain in a wretched hole, we have managed to put in our time to-day most pleasantly. She is a regular brick!"

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He proceeds:

It was about this time that I joined the Royal Irish Academy, where I subsequently read several papers. I also busied myself as much as possible in the work of the various scientific societies in Dublin. I also became a member of the Council of the Royal Zoological Society.

I think it was Lord Russell of Killowen who once told me that the ideal way to present a narrative is to adhere closely to the order of date. As I have now arrived at the year 1869, I mention a lecture which I heard in the spring of that year which had a very material effect on my future life. It related to the movements of the shooting stars which had appeared in the great shower three years before. Dr. Stoney, with that originality which improved and enlightened every subject he touched upon, gave the lecture. He had occasion to explain that the shooting stars moved in an elliptic track,

and he illustrated his remarks by means of a heavy leaden ball suspended by a wire from the roof of the theatre of the Royal Dublin Society. When drawn aside, the ball moved in an ellipse, the position of which gradually altered.

At the time I was not very familiar with the mathematical principles by which these movements could be explained, but as soon as I returned home after the lecture I commenced to consider the subject. I found it to be one of absorbing interest. Prolonged investigation enabled me to ascertain some points in connection with the movements which did not appear to have been published before. Eventually I wrote a paper which was duly published by the Royal Irish Academy. From this I was led on to a general examination of the movements of a rigid body about a fixed point. These researches gradually developed into a theory still more general, and finally became what is now known as the "Theory of Screws," on which I have written much. Indeed, the investigation of this subject has been one of the main occupations and certainly one of the great interests of my life. Even now I look forward to the summer holiday, because I know I shall then be able to devote some hours every day to uninterrupted study of this subject.

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Thus far the personal narrative. It was always a saying in the family that my father's idea of rest and recreation was to move to another place wherein to work at mathematics. Whatever pleasant spot was chosen for the summer holiday, a private sitting-room was invariably engaged where he could labour undisturbed.

In particular I remember one visit to Pontresina, where the windows of the sitting-room in the Kronenhof gave upon the beautiful Roseg Valley. While the other members of the party were out on expeditions, my father would work and write and think there for four or five hours at a time—plunged in an intellectual world of his own the beauties of which were revealed to none save himself.

The following letter to his son Robert shows that golf and mathematical research shared his attentions during a holiday :

"We have had a good time at Buncrana. All, I think, enjoyed themselves; I know I did. When I was tired of golf I worked at screws, and when I was tired of screws I played golf,

and I really do not know which I liked the best; both were delightful. I hope you will take to golf."

When he published an edition of the "Theory of Screws," many years later, my father did not forget the man to whom he owed his inspiration. He wrote to Dr. Stoney (December 23rd, 1889):

"I send you herewith a volume which gives an account of the Theory of Screws which is tolerably complete. Please accept it.

"About twenty years ago you will recollect giving a lecture on Meteors at the R.D.S., in which you employed the pendulum to illustrate the progression of the apse. This set me thinking on the dynamical problem of the pendulum, thence of the small oscillations of a point generally, and from thence to a rigid body, by which I was gradually led on to the theory which, as you know, has occupied much of my attention for many years.

"I have always felt grateful to you for thus starting me on a line of thought which has given me many delightful hours of investigation."

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My father's narrative may now be resumed:

Among the colleagues with whom I commenced to work at the Royal College of Science I should especially mention Dr. Ramsay Traquair, an accomplished palæontologist. Some years later he was appointed Director of the Natural History Museum of Edinburgh.

I should also mention my lifelong friend, Sir W. Thiselton-Dyer, K.C.B. He was Professor of Botany at the College for some years, and was then promoted to be Assistant-Director of Kew Gardens. Later on he occupied the important position of Director at Kew.

Another friend, of whom I saw a great deal in those days, was Professor E. Hull, F.R.S., who was Director of the Geological Survey in Ireland while I was at the College of Science. In the spring of 1880 he and I paid a delightful visit to the Auvergne, where we investigated the geological wonders of the district.*

Sir W. F. Barrett joined the college during my time, as Professor of Physics. He came to Dublin with an established

* An account of this expedition will be found in Professor Hull's "Reminiscences of a Strenuous Life" (London: Hugh Rees), at p. 89.

reputation, having been assistant to Professor Tyndall at the Royal Institution; but he had already made a number of investigations on his own account. In particular he had astonished the scientific world by his beautiful discovery of flames which would respond to sound. I well remember the arresting lecture which he gave on this subject at the Royal Dublin Society.

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Leaving the personal narrative again for a moment, I here insert an account of my father's work at the College of Science with which Sir W. F. Barrett has kindly supplied me:

"My acquaintance with Sir Robert Ball began forty-five years ago, when I was invited over to Dublin to deliver a lecture before the Royal Dublin Society. The Royal College of Science for Ireland had come into existence shortly before that time, and Ball held the position of Professor of Applied Mathematics and Mechanics in the college. When, a few years later, largely through his kind interest in the matter, I was appointed to the Chair of Experimental Physics in the college, we became colleagues, and the affectionate friendship thus begun, continued intimate and unbroken ever after, and remains one of my most valued possessions.

"To the success of his teaching at the College of Science his old students—many of whom now hold eminent positions in all parts of the world—have often testified. He was, I believe, one of the first to introduce the C.G.S. system into class teaching, and a large collection of weights and measures and models to illustrate this system were made under his direction. But his work at the college will be chiefly remembered by his splendid adaptation and extension of Willis's apparatus for the teaching of experimental mechanics. His well-known volume on this subject was the outcome of his lectures both to the regular students and of the series of popular evening lectures which he inaugurated at the college. I remember the ingenuity and skill with which he fitted up the large pieces of apparatus until the wide space behind the lecture table was almost full, and then the wonderful lucid and delightful expositions he gave, interspersed with his unfailing humour. He threw his whole heart into his work, and enjoyed his lectures as much as did his enthusiastic audience. In the

originality and wide learning displayed in his lectures he was *facile princeps* among his colleagues. He endeared himself to all by the keen interest he took in the welfare of his students and of the college generally, so that his name must ever be remembered by his former colleagues and by his old students with the deepest affection and respect. Indeed, it would be hard to find a more lovable, generous, and high-minded personality than that of my dear friend Robert Ball."

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To resume the personal narrative:

Amongst the friends of those days I remember Professor J. T. O'Reilly, who at that time filled the Chair of Mineralogy and Mining. In later years, long after I left, he became Secretary to the college.

I also recall Sir Robert Kane, who had been a friend of mine since childhood. Before coming to Dublin he had been President of Cork College, and he then became head of the College of Science.

Lastly, I must not forget my friend Dr. Sidney, who was Secretary to the college in my time.

The early days of the institution were fraught with considerable anxiety. The prospects were by no means encouraging. Students were exceedingly few in number, and of those who did attend the majority were mainly induced to do so by the fact that good scholarships were provided for them by the Science and Art Department. No member of the staff was responsible for the scheme of education. Everything of that kind had been arranged by the Commissioners, who had drawn up a plan for the college. Let me say at once that they had done their work most admirably. But their views were greatly in advance of the times. I am speaking of forty years ago. Anyone proposing to found a scientific college at the present day would do well to study the proposals originally made for instruction at the institution with which I was connected in Dublin. But the parents of those days were somewhat reluctant to place their sons under a *régime* which they deemed problematical. There was another circumstance which tended to increase this feeling of hesitation in parents. It was that the Government did not appear to be very sanguine of success. It was provided in the con-

stitution that, if at the end of seven years, the college was not found to be prospering, it should be abolished, in which case the professors were not to be entitled to claim compensation for loss of office. This uncertainty of tenure undoubtedly had a very depressing effect upon all who were interested in the starting of the college. It was certainly disquieting to those of us who had burnt our boats in accepting professorships. Although we were all filled with anxiety then, it may have been that the insecurity was a blessing in disguise. Looking back at this distance of time, I am not at all clear that in some respects the threat which was hanging over the staff was not advantageous. It certainly induced us to make strenuous efforts to make the college a success. At any rate, we did keep it on its legs, and now, after the lapse of forty years, it has grown into a strong and powerful institution. Only recently I learnt that it is to be transferred from the original quarters, in which it was somewhat cramped, to an ample and splendid building.

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His old pupils did not forget him. Thirty-one years after he severed his connection with the college he was entertained at dinner in London by a number of men who had attended his lectures on experimental mechanics. He describes this event in a letter to Mr. Charles Steele (March 24th, 1905):

"Even though they are so very tardy, will you please accept my thanks for the magazine containing the account of poor O'Reilly.

"It was the first intimation I had of his death.

"I had always, like so many others, the warmest affection for O'Reilly. We often differed as widely as the poles in matters of policy in the College of Science, but that never interfered in the least with our personal regard. My room upstairs was opposite his, and whenever I had fixed up some mechanical experiment for my class I used always to go over to get O'Reilly to come and look at it, and we had many a pleasant chat. I was always so glad to see him on my visits to Dublin in later years.

"I was entertained at dinner on St. Patrick's night by the old students of the college. We dined in a wonderful room in the Holborn Restaurant belonging to the London Piscatorial Society, which is decorated with the most magnificent cases of stuffed fishes, including everything that ever took a bait from a tarpon to a gudgeon. There was a party of thirty or more,

and I was amazed and delighted to find how wonderfully well many of the old students have done. I brought down the list of twenty-two who signed the testimonial they gave me when I went to Dunsink, which I have so greatly prized ever since. It was very ineresting to inquire as to their welfare after the lapse of thirty-one years. As might be expected, two or three are no longer with us, and two or three more I could not trace, but all the rest appeared to be doing well, and some extremely well. The first, Arnall, is in an important position in the Borough Council at Birmingham; the second, S. Barratt, is now one of the directors of Rylands and Co., a gigantic cotton firm employing 12,000 hands. He is in a fair way to become a millionaire. Denis Coyle, whom I recognised at once, is the rector of a parish; Cooper is Drainage Surveyor at Wimbledon. But I won't go through the whole alphabet. Henry Spunner is the last, and I believe he is a land agent in Ireland.

"I always thought, and still think, that the course in the Royal College of Science is the best educational course in any college. We are beginning to find that out, and are making efforts to bring our colleges over here into something like the same efficiency.

"The percentage of men who have done exceedingly well in the world from the College of Science is, I believe, quite phenomenal.

"Many kind things were said of poor O'Reilly."

It would be impossible to enumerate all the old students of the college who have made their mark. My father kept in touch with several in distant lands, among whom may be mentioned Mr. Richard Montfort, the distinguished chief engineer of the Louisville and Nashville Railway.

After my father's death in 1913 a number of gentlemen holding important positions at the London Patent Office wrote to my mother saying that they owed their first instruction in mechanics to his teaching at the Royal College of Science.

CHAPTER VIII

ASTRONOMER ROYAL OF IRELAND: 1874–1892

MY father prepared memoranda relating to his appointment and duties as Astronomer Royal of Ireland. He also dictated some notes of his work and experiences at Dunsink Observatory. The first part of this chapter consists of autobiographical matter; in the latter part I have collected notes and correspondence which properly relate to the period between 1874 and 1892.

He wrote as follows:

In the year 1874 Dr. Brünnow (to whom I shall refer again) resigned the post of Royal Astronomer of Ireland, and it devolved upon the Board of Trinity College to appoint a successor.

Upon this occasion my kind friend Dr. Haughton once more came forward. He urged me to apply. I felt that this was rather presumptuous on my part, and I consulted other friends. In particular I sought the advice of Richard Townsend, the distinguished mathematician, who was to me—as indeed he was to so many others—one of the kindest of friends and counsellors. Townsend urged me to make the application. I summoned up my courage and did so. I still felt that I was somewhat audacious. However, by this time I think I must have made some impression on the scientific world. I had become a Fellow of the Royal Society. I was in correspondence with Professor Klein and other eminent mathematicians. I had also had experience at Parsonstown with Lord Rosse. Under his guidance I had acquired a knowledge of practical astronomy.

There were several other candidates, as the post had many attractions, including a beautiful residence in the vicinity of Dublin. The Board had some hesitation in coming to a conclusion. After the matter was decided, I heard that Dr. Brünnow had strongly urged the electors to make me his

successor. After one or two postponements I was appointed. I called the next day on the Provost, Dr. Humphrey Lloyd, so well known for his eminence in physical optics. Having received me most cordially, he said: "I am delighted to say that I was beaten yesterday. I did not vote for you; I voted for Mr. Marth." I do not think that the candidate referred to —the late Mr. Marth—had any support other than that of the Provost, but that was great support indeed. Mr. Marth was an astronomer who had distinguished himself both by his practical observations with Mr. Lassell's great telescope and also by valuable theoretical calculations in relation to the movements of the celestial bodies.

It was thus that in the year 1874 I found myself Astronomer Royal of Ireland, and Andrews Professor of Astronomy in the University of Dublin. Let me now give a few particulars as to the office which I held for eighteen years. The professorship was founded by Provost Andrews at the close of the eighteenth century. He not only endowed the Chair of Astronomy, but he also supplied funds for the erection of the observatory. The money so bequeathed was added to from time to time by the generosity of the Board of Trinity College. A site was chosen at the north of the Phœnix Park, where a gentle slope ascends from the little river Tolka. On the summit of this slope, at an altitude of three hundred feet, four and three-quarter miles from the Post Office in Dublin, Dunsink Observatory was erected. There is a magnificent prospect from the site. Away to the left are glimpses of the sea and of the city of Dublin; in front is the Phœnix Park and the beautiful range of mountains which includes the Three Rock and Two Rock. There is an occasional peep of the Wicklow Mountains behind, and the range gradually declines, and ends away to the west in the beautiful wooded hills. The place lies some distance from the railway, and there are no trams or other facilities for reaching it. Those who built the observatory appear to have thought it must be necessary for the Astronomer Royal to keep horses and carriages; at any rate, a range of stables was provided which was somewhat out of proportion to the establishment which a man of science is generally able or willing to maintain. There was also an extensive garden and some fourteen acres of land. Thus the astronomer was able to combine small farming operations and

horticulture with his astronomy. It was to this abode that I went with my wife and three small children in the summer of 1874. Dr. Brünnow had most kindly remained at the observatory for some time, with the benevolent intention of giving me some assistance in the use of certain instruments of which I had had no experience at Parsonstown.

Let me now give some account of my predecessors. The title—Royal Astronomer of Ireland—was not, and of course could not be, conferred by the University. They appointed an Andrews Professor, but by Royal Letters Patent it was decreed that whoever held the position of Andrews Astronomer should be deemed Royal Astronomer of Ireland. The title still survives, though, unlike the Royal Observatories both of England and Scotland, the Government has no say whatever in the management of the institution, nor does the Crown provide any part of the emoluments of the Royal Astronomer, or make any contribution towards the upkeep of the establishment. The astronomer is appointed and the expenses of maintenance are entirely provided by Trinity College.

The first illustrious name among my predecessors is that of Brinkley, who was a Senior Wrangler at Cambridge, where he belonged to Gonville and Caius College. He set himself with great assiduity to the work of the observatory. That was the time when the desire for great telescopes was beginning to be felt, under the influence of Ramsden, the renowned optician. The erection of a great telescope was determined upon by Ramsden and Brinkley, the Board of Trinity College loyally supporting them. But lengthy delays ensued. Ramsden had but a small staff of workmen. Other business interfered, and he suffered from bad health. Year after year went by, and the Board at each annual visitation found that the place for the telescope was still vacant. It is somewhat difficult to believe it now, but it is a fact that the great instrument was not ready for work until the lapse of eighteen years after Brinkley's appointment. He then made a gallant attempt—even if the attempt was not altogether successful—to solve one of the most difficult problems of practical astronomy; he sought to determine the distances of certain stars from the earth.. Up to that time this problem, though often essayed, had never been solved. These distances are so

vast that no instrument theretofore constructed possessed the delicacy of adjustment necessary for success. But Brinkley cleared the ground for subsequent investigators, and thus largely contributed to the success of more recent endeavours. We now know that the great circle constructed by Ramsden's genius was hardly the proper instrument for these researches, but no one knew this in Brinkley's time. He had been waiting eighteen years for his instrument, and he then used it for another eighteen years. Although he worked at astronomy with such assiduity, he did not allow his studies of the heavens to occupy his attention to the exclusion of all other subjects. He was an eminent mathematician, and he was also a divine. In his clerical career he seems to have been as diligent and successful as he was in his midnight researches in the observatory. One preferment followed another, and although he never appears to have had anything like parochial duties to discharge—which would, indeed, have been incompatible with his work as an astronomer—we find that he attained the dignity of an archdeacon. Finally, this Royal Astronomer of Ireland became Bishop of Cloyne. In that position he succeeded Berkeley; it was fitting that the see which had been rendered so conspicuous by the intellectual fame of the great philosopher should now be filled by one whose scientific claims were universally recognised. No one possessed these claims in a higher degree than the illustrious Brinkley. His career as an astronomer having thus come to a close, the observatory which he had adorned for thirty-six years was again vacant.

Shortly before Brinkley's resignation, a young student had appeared in Trinity College whose distinction was so phenomenal that, although he was quite young—hardly, indeed, of age—he was immediately thought of as a probable successor. His name was William Rowan Hamilton. Such was the versatility of this young man's genius, that if a vacancy had taken place in any Chair—Mathematics, Natural Philosophy, Moral Philosophy, or even Classics—it is certain that his name would have been thought of in connection with each one of those posts. The story of the wonderful youth of Hamilton has been completely told by his most conscientious biographer and lifelong friend, the late Rev. R. P. Graves. Many of the stories of his genius may well be deemed fabulous by those who have not referred to the pages of Graves's pains-

taking volumes. Let me recall a few of the stories of Hamilton's childhood. His early years were spent at Trim, in County Meath. One day his aunt, with whom he lived, took him to call on the rector of the parish. Little Willie Hamilton was then five years old. He was playing about on the floor with some small companions when the rector came into the room. Noticing this vigorous, healthy child romping about with screams of delight, the rector said to his aunt: "Of course I can hardly believe those stories that I hear of that child—as, for instance, that he is able to read Greek!" The aunt was never anxious to make any display of the child's powers, and so she parried the question. But the rector returned to the matter, and she said, "Try him." Whereupon he took down a volume of Homer from a bookshelf. Seeing that it was in contracted writing, he said to the aunt: "Oh, well, this wouldn't be fair." The aunt replied: "Never mind; try him." The boy at once read off the Greek, contractions and all, perfectly! On another occasion when the child's prowess was being shown, his aunt said: "Now I think Willie will be able to puzzle you." This he most certainly did by reading the Greek equally well when the book was turned upside down. When he was six years old, he was spending the day with some other child who must also have been a prodigy, though we don't seem to have heard much about him or her. When Willie came home he was observed to be crying at his supper, and on inquiry as to the cause, he said it was because the other child would insist on reading Hebrew without a point, which he considered to be wrong. When ten years old he used to translate the Epistle and the Gospel for the day on Sunday into Syriac, and before he was twelve years old, after expressing regret that the knowledge of Syriac in Ireland was so lamentably behind what it ought to be, he set to work to write a Syriac grammar! The grammar was actually written, and the proposed title-page is reproduced in Graves's book, though the work itself never, in fact, went to the printers. When William Hamilton was fourteen, a Persian Ambassador came to Dublin, and young Hamilton addressed to him a letter in Persian, eliciting from His Excellency a remark to the effect that he did not think anyone in Europe could have done such a thing! So far his studies were mainly linguistic, but he varied them with other subjects. He made tremendously

long calculations with reference to the date of an eclipse. He read swiftly through the ordinary books of mathematics, and grappled with the very highest subjects in Laplace's "Mécanique Céleste." When sixteen years of age he paid a visit to Brinkley in order to submit to him an original essay on "Rays" which he had written. Even now this "Hamilton System of Rays," the germs of which were the production of this wonderful boy of sixteen, is one of the most striking examples of modern mathematical genius. In due course he entered Trinity College. He was always described as a most modest youth, never presuming in the least on his extraordinary gifts; but still, his reputation must have preceded him. It is said that when he called on the tutor to make the necessary arrangements on his entering the college, the tutor observed: "Well, we are proud to see you, but I really do not know who will be able to teach you anything in this place. This much, however, I will promise you, that, if at any time I see you losing your balance by reason of the fame that will accrue to you, I will most certainly reprove you as a father should."

And so Hamilton entered Trinity College. All the classes were then arranged in order of merit. When the classical students were so arranged, William Rowan Hamilton was at the top. When the mathematical list appeared he was again at the head, and a line was drawn beneath his name to show that the rest were nowhere. There was a special prize given for English Verse Composition—Hamilton carried off the prize. In his course through college he absorbed knowledge at every pore, and drew around him a cluster of friends, many of whom were to influence his later life in a marked degree. Indeed, he had a wonderful power of attracting friendship, and friendship of the very worthiest kind. Mr. Graves's work is filled with Hamilton's correspondence in his later years.

Hamilton had not yet taken his degree when Brinkley was appointed to the bishopric. Other candidates for the Chair of Astronomy were, of course, forthcoming. With characteristic modesty Hamilton at first thought it would be undue presumption in him to stand. But friends who knew of his incomparable genius successfully urged him to allow his name to be submitted to the Board. Among the candidates was Airy,

who became Astronomer Royal of England. Of course, Hamilton had no practical experience of observatory work, but he had a mastery of what was much more difficult—he understood the abstruse principles of theoretical astronomy. Further, by his work on eclipses he had already shown himself to be an adept in astronomical computations. Almost all his friends—especially those connected with the University—were anxious for his election. They felt that, by giving him the first available appointment, they would secure for the University the talents and renown of one who seemed destined to be among the greatest scientific men who ever lived. There was, however, one man who thought that Hamilton ought not to come forward. That was the good bishop himself. Brinkley did not for a moment doubt Hamilton's competence for this—or, indeed, for almost any other intellectual employment—but Brinkley thought that his temperament was not so well adapted for secluded residence at the observatory as it was for association with the active minds in Trinity College. Let it be remembered that those were the days of McCullagh and of Humphrey Lloyd—names writ large in the history of science. Brinkley also thought that Hamilton's *forte* lay in the exercise of marvellous intellectual powers, where abstract reasoning was concerned, rather than in the practical manipulation of instruments and the conduct of observations. Looking back now on Hamilton's career, we can see that the bishop was not quite right on this occasion. At any rate, we know this much for certain—that Hamilton's career at the observatory during a period as long as that for which Brinkley had himself been Astronomer Royal, was a procession of intellectual victories, and that, up to the last moment of his life, he continued to pour forth with unbounded profusion those works of immortal genius which have made his the greatest name in the annals of the University of Dublin, and one of the greatest names in scientific history.

During Hamilton's time there was not very much work done in actual observation of the heavens. He was far better occupied in perfecting the invention of "Quaternions" than in the details of taking transits, or of carrying through elaborate astronomical investigations. Of course, he had an assistant—a Mr. Thompson—who did the routine work with such instruments as the observatory placed at his disposal. But the years

had rolled on, and the great eight-foot circle which in Brinkley's time was deemed such an advance upon astronomical instruments previously known, had become now somewhat antiquated. Consequently, when Dr. Brünnow, who succeeded Hamilton, commenced his work at Dunsink, he found that a complete renovation from top to bottom was necessary.

When I was at Trinity Sir William's life was drawing to a close. We undergraduates used to see him at rare intervals. He was a recluse, engaged in profound original mathematical speculations. Mr. Graves records that he would often go into mathematical trances, in which he would work for hours and hours together, wholly oblivious of time. Indeed, he was only made aware of the approach of night by the fact that he had to light his candle. He also disregarded the usual hours for meals, and he hopelessly neglected the ordinary occupations of life. Strange stories are told of the condition under which the house was managed during those years. He never destroyed a letter, and he kept copies of most of the letters he wrote himself. These habits were no doubt exemplary; but he had not the remotest idea of any method in the preservation of his papers. In the study where he worked, books, papers, and letters were heaped together in indescribable confusion. They overflowed from the bookcases and the shelves on to the floor. They were not only piled in corners, but they spread over the room in an ever-deepening mass, until his study (as I was told by a nephew of the great man) presented a most extraordinary appearance. There was a kind of laneway from the door to his writing-table, on either side of which papers, books, letters, and mathematical manuscripts were heaped together to a depth of two or three feet. Visits of the housemaid to this sanctum were rigidly interdicted. Soaring aloft in mathematical speculation, Sir William was utterly oblivious of the sound of the dinner-bell. When at last Nature did make some food necessary, a chop would be handed in on a plate at the door. The nephew above mentioned declared to me that when he visited the room he saw many of these plates, with the chop bones on them, thrown about on the piles of manuscripts! In the summer-time he would sometimes adjourn to a meadow, where he would work for hours under a haycock. When rapt in thought he brooked no interruption. To an inquisitive person who inquired what mathematical problem

he was engaged upon he is reported to have answered: "Oh! I'm trying to multiply the N.E. by the S.W.!"

I only spoke to Hamilton upon two or three occasions. I recollect the first of these best. My father knew him slightly, having been treasurer of the Royal Irish Academy when Hamilton used to read his papers there. It must have been in the year 1854 or thereabouts that my father took me to Dunsink. I was fourteen at the time. My father had some overrated idea as to my mathematical attainments, and thought he would like me to talk to Sir William. I have not the slightest doubt that Hamilton thought the whole thing a great bore, but he was kindness itself, and we had lunch with him. I forget all about the lunch, and I do not even remember in which room it was given, although I myself have since lived in the house for eighteen years. But I do recollect certain questions which Sir William put to me on the roof. This roof was always a favourite resort for visitors, as it commanded a superb view. The first question he asked me was, "What two numbers are there whose sum is nine and product fourteen?" When I answered at once seven and two, he said, "Oh, you guessed that!" He then turned to my father, and for several minutes talked of something mathematical which I did not understand. I say it with all respect, but I rather fancy my father did not understand it either. Sir William next asked me: "What is meant by the sine of an angle?" When I replied that it was the ratio of the perpendicular to the hypotenuse, he at once exclaimed: "Ah! I like to hear that! I am so glad to think that the old notion of representing the sine as a line is being replaced by the notion of the sine of an angle as a ratio." This change of thought took place so long ago, that I do not suppose that many of those who study mathematics ever even knew that a sine was at one time looked upon as a linear magnitude, and not as a ratio or abstract number.

I saw Sir William Rowan Hamilton two or three times during my undergraduate course, and I heard him read one or two papers at the Royal Irish Academy. I also heard him speak at the Philosophical Society in Trinity College. But I cannot truthfully say that this latter performance was very edifying. Some undergraduates—for there are undergraduates to whom even genius such as Hamilton's is not a sacred thing—had managed by some trickery that he should appear on the platform

arrayed in a junior freshman's gown! This rather detracted from the dignity of the occasion. Although he never examined me personally, Sir William did his share of examining students in college. It used to amuse us, when undergraduates, to read in Tait's "Elements of Quaternions" that "Hamilton, *in spite* of his great originality, was one of the best examiners ever known." That the papers set by him were brimful of his abounding genius is undoubted. Indeed, the questions which he set, frequently had relation to the quaternions which he had himself invented. The problems were often altogether beyond the candidates. Even at the present day few examinees in any university would be able to make anything of his conundrums. His methods as examiner were sometimes remarkable. For instance, on one occasion a friend of mine, now a distinguished member of Trinity College, was the only candidate for a certain mathematical prize. The statutes provide that the Andrews Professor must conduct that particular examination. Shortly before the appointed time Sir William Hamilton and the solitary candidate were both approaching the examination hall at the same moment. Upon seeing this one victim, Sir William immediately inquired whether anyone else was likely to come forward. He was assured that there was no other candidate. There were still a few minutes until the hour at which the examination was timed to commence. Pointing to the chains round the square grass plot, Sir William said: "Let us just sit down here for a minute or two." Down they sat on the chains, thereby committing what was in itself a serious breach of college decorum. Sir William then produced a printed paper. My old friend the candidate was rather uneasy, for, to put it mildly, his knowledge of quaternions was of a very meagre description. Sir William then opened the paper and showed it to the candidate, who ventured to make some slight remark indicating that he had only the slenderest knowledge that anybody could possibly have on the subject of quaternions. Instantly the examiner himself began to develop the subject. He went on talking, talking, talking until after the clock struck. He continued talking for an hour or more, the candidate quietly punctuating the discourse every now and then with "Yes, yes." Finally, as the examinee gave no further indication either of his knowledge or his ignorance, Sir William declared that he was delighted to find that

quaternions had at least one faithful admirer, and that he was greatly pleased with the knowledge of the subject evinced by the candidate, and that any more formal examination would be obviously superfluous!

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The following is an anecdote concerning Sir William Hamilton which my father used often to tell in his popular lectures:

Hamilton was visited on one occasion by a lady who wanted to see some of the wonders of the heavens. It was daytime, and it was not easy to exhibit stars under those circumstances, so Sir William proceeded to show some terrestrial objects which would illustrate the power of the telescope. Three miles distant from Dunsink Observatory, in the Phœnix Park, is a well-known monument to the great Duke of Wellington. The monument is an obelisk, and the names of the Duke's battles are engraved around it, so Sir William turned the telescope upon the obelisk. The lady was delighted with all she saw, and exclaimed that not only could she see the stones of the building, but she could even see the names of the battles. "What names can you see?" asked Sir William. "Oh," said the lady, "I can see—yes, S-a-l-amanca." The astronomer was thunderstruck. "Madam," exclaimed he, "with your wondrous eyes you would solve the problem that has puzzled all the astronomers that have ever lived. You should be able to tell me what is on the other side of the moon, for Salamanca is written on the other side of the monument!"

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My father's account of Dunsink then proceeds:

I have already referred to Dr. Brünnow, who succeeded Sir William Hamilton as Astronomer Royal. He was a distinguished German mathematician and astronomer, who had commenced his career at the Ann Arbor Observatory, in Michigan. He had married the daughter of Dr. Tappan, the President of the Ann Arbor University. After leaving Ann Arbor, he and his wife retired to Germany. From thence Brünnow was summoned to Dunsink Observatory. I believe he was appointed on the recommendation of Professor Adams, who had mentioned his name to Humphrey Lloyd, then Provost of Trinity. Dr. Brünnow did excellent work at Dunsink. He erected new telescopes, and made some remarkable observations with a

view to determining the distances of stars. During his stay of a few years he completely transformed the instruments, and raised the observatory from being an establishment with a very poor equipment to one which, for its size, was comparable with any other observatory in the world. It has, indeed, been said by the late Dr. Copeland—my valued old friend who was the Astronomer Royal for Scotland—that in all probability the meridian circle, which Dr. Brünnow caused to be erected, was at that time the finest instrument of its class. But the attractions of the Continent reasserted themselves. Brünnow's health had not been strong, and so he determined to resign the post at Dunsink. Upon his retirement he went to Basle, where he devoted himself with the utmost ardour to music. Music had been a passion of his life. In one of his last letters to me he mentioned that when a young man he had for some time hesitated as to whether he would allow astronomy or music to shape his career.

When I became Astronomer Royal, Dr. Ralph Copeland was Assistant Astronomer. He was a man of very extensive scientific attainments. An Englishman by birth, he had spent some years in a German observatory. At one time he had joined an Arctic expedition, during which he did some excellent surveying. He was extremely skilful in all mechanical matters, and had a very useful practical knowledge of instruments, having had charge of Lord Rosse's telescope for some years. When I first went to Dunsink, Dr. Copeland was absent. He had obtained special permission to join the famous expedition organised by Lord Lindsay (subsequently Earl of Crawford) to Mauritius, in order to observe the Transit of Venus.

In the course of a walk one morning through a forest in Mauritius he found the bushes covered with spider cocoons. He filled an envelope with them, and gave me a few when he came back. It was from these that we furnished the micrometer Transit Circle at Dunsink with spider lines.

I don't know the name of the animal exactly, but it ought to be called *Latrodectus Micrometricus*. *Latrodectus* is the most venomous genus of spiders, and we may fairly expect something of the kind to come from such a locality!

Dr. Copeland ultimately became Astronomer Royal of Scotland as successor to Dr. C. Piazzi Smyth. Piazzi's father, Admiral Smyth, was well known as the author of a book

which probably did more to create lovers of practical astronomy than any book ever written. I allude to Smyth's "Cycle of Celestial Objects." He christened one of his sons after Piazzi, a famous Italian astronomer. I knew Piazzi Smyth well, and had many letters from him, which he always courteously commenced by the phrase, "Dear Brother Astronomer Royal."

Piazzi Smyth devoted himself very largely to the spectroscope, while he illustrated his work so beautifully as to prove himself an accomplished artist. In his young days the advantage which the astronomer gains by placing his instruments on a high altitude was not so fully recognised as it is now. In this respect Piazzi was a little ahead of his time, for he made an expedition to Teneriffe, and having managed to erect his telescope on the top of the famous Peak, he realised his expectation that a great improvement of vision was to be obtained from such a height. In later years I sometimes visited him at his beautiful house in Edinburgh, when he took a great delight in describing the results of his spectroscopic investigations. He was then totally deaf. Indeed, it was only possible to communicate with him by writing on a tablet which he always carried for the purpose. His flow of conversation, however, was so inexhaustible that a visitor found few opportunities for making use of the tablet. I remember one occasion, of which he was perfectly unconscious, on which our conversation was conducted under still more difficult conditions. He had taken me into his laboratory to show me his spectroscope. In order to produce an electric spark he made use of a very powerful coil. This coil made a noise which was absolutely deafening. Piazzi Smyth knew nothing of this, but it prevented me from hearing a single syllable he uttered.

In his later years Piazzi was largely known by certain investigations which he made in connection with the Great Pyramid. He devoted many months to careful and elaborate measurements of the stones, the site of the pyramid, the sarcophagus, and the directions of the passages in the pyramid. The results of his arduous labours were given to the world in three big tomes known as "Life and Work at the Great Pyramid." Whether the theories he advocated in these volumes will be universally accepted I do not know, but no man can gainsay the charm of the book. A brilliant writer, he produced a work which is most excellent reading from beginning to end.

His main thesis, so far as I can remember, was that the builders of the pyramid desired to record in that great building, in a manner that should be handed down to the remotest posterity, the knowledge of certain very important constants which they had ascertained. Piazzi Smyth sought to show that by certain multiplications of the dimensions of the sarcophagus and other points in the dimensions of the pyramid, and by taking into account certain other factors, it was possible to obtain a figure which corresponded to the mean density of the earth. He was of opinion that the ancient Egyptians, having learned this from revelation or by research, desired to perpetuate it in an enduring manner. I only mention these particulars because of the following somewhat absurd incident in which I took a small part.

I was invited to attend a lecture on Egyptology which was to be given by Mr. L. E. Steele at Kingstown, Co. Dublin. The lecturer made some allusion to Piazzi Smyth's writings, and I was called upon to make some remarks. I knew nothing of Egyptology, so I repeated a little story which I had heard somewhere or other a short time before. It was to the effect that when Piazzi was making one of his communications at some scientific society, one of those present got up afterwards and said something like this: "I think the methods introduced by Professor Piazzi Smyth are of the greatest interest. They may be extended not only to measurements of the Great Pyramid, but to other measurements as well. In fact, while the learned professor has been addressing you, I have myself been making a series of measurements with a pocket rule. I have been measuring the dimensions of my hat. I find that if I divide the diameter of the hat by the precession of the equinoxes, add the logarithm of the depth of the hat to the coefficient of the aberration, and take the square root of the whole, I arrive at a number which is the identical age of Mr. Gladstone." This, or something like it, was what I said. Great was my horror on the following day to see a report (or what purported to be a report) of the meeting in the newspapers, though the only matter recorded was the little story which I had been guilty of telling! For many days afterwards I shuddered at every postman's knock. I was in mortal terror lest I should find a letter from the Royal Observatory, Edinburgh, heaping coals of fire on my head

by addressing me as "Dear Brother Astronomer Royal," and remonstrating with me for having been instrumental in perpetrating a somewhat sarcastic joke on the professor's Egyptian theory.

Apparently the Irish newspapers did not reach Edinburgh, and fortunately there were no kind friends at hand to send him a cutting. So I never received the letter I dreaded. If this should meet the eye of any old friend of Piazzi Smyth, I hope he will forgive my share in the matter.

I have already explained that for six years I had been a professor of mechanics. In that capacity I had to give many lectures in the College of Science, but in spite of that I managed to devote a certain amount of time to original work. But I felt that the time given to routine work at the college greatly interfered with the research which I thought I could attempt if I had the opportunity. So I therefore gladly welcomed the chance of getting into the observatory, where I would be largely master of my own time, and where I was only compelled to lecture upon two days a week during one term in the year. Of course, the idea of thus limiting the professor's work is that he may be able to devote more time to original research.

When I reached Dunsink, I continued the investigations which Dr. Brünnow, my predecessor, had been making with a view to ascertaining the distances of the stars. This problem had been attacked at a much earlier date by Dr. Brinkley. There was at Dunsink an instrument which we knew as the "South Equatorial." The word "South" in this connection did not refer in any way to the geographical position of the instrument, but to the name of its donor, Sir James South, who died in 1867, within a week of Lord Rosse. Astronomy owes much to Sir James South. I think it was De Morgan who described him as the "Starlight (k)night."

I do not propose to go into detail about my work. So far as it deserves to be placed on record it is to be found in the annals published by the Dunsink Observatory.

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I interrupt the personal narrative at this point to insert an account of my father's work at Dunsink with which Dr. Dreyer, of the Armagh Observatory, has kindly supplied me:

"When Ball went to Dunsink in the summer of 1874,

only a few years had elapsed since the observatory had resumed its place among active astronomical institutions. Sir William Hamilton had devoted himself solely to pure mathematics, and published neither observations nor any other astronomical work. But his successor, Brünnow, had done some excellent work in determining the annual parallax of stars with the new refractor of eleven and three-quarter inches aperture, and Ball decided to continue and extend this interesting work. In 1874 the refractor was, however, in Mr. Grubb's hands for alterations, and as the newly appointed assistant, Dr. Copeland, was absent on a Transit of Venus expedition, Ball devoted himself during his first winter at Dunsink to the newly mounted Transit Circle. In 1876 he took up work with the refractor with his usual energy. In addition to parallax work on a few selected stars, regularly carried on throughout the year, he broke fresh ground by attempting to find stars with a large parallax by what he called 'reconnoitring observations.' He formed an extensive working-list of stars, interesting on account of their colour or proper motion or other peculiarity. These he only observed a few times at intervals of six months, and if the observations of a star agreed well *inter se* he did not attend any further to that star. But in a few cases where the observations differed a little in the way they ought to differ—if the star were within a measurable distance from us—he observed it regularly, and as often as possible, throughout a year, in order to determine the actual amount of the parallax. Though he did not succeed in finding any star with a large parallax in this way, the experiment was an interesting one, and even the negative result, showing that stars with a large parallax must be very few in number, was of value. For some years he worked very hard at these parallax observations, generally continuing work till between two and three o'clock in the morning. The reduction of the observations and their preparation for the printer were planned and arranged with the utmost care, so as to avoid all unnecessary copying and reduce the arithmetical work as much as possible. The observations were entered at the telescope into 'duplicate order books' with detachable leaves, which could be removed, sorted according to the object observed, and sent straight to the printer. All calculations were made on printed forms, and every auxiliary quantity that could be tabulated beforehand was entered in

tables pasted singly on cardboard, and therefore more convenient to use than tables written in a book. Having arranged the computations in this thoroughly practical manner, it was easy for him, when, after the first couple of years, other work claimed more of his working hours during the day, to send the observations to a computer at a distance to have the results worked out. He was very enthusiastic about this parallax work for some years before trouble with his eyesight obliged him to give it up. Thus, when he was staying at Greystones during August and September, 1879, with his family, he hurried up to Dublin and out to Dunsink whenever a very promising, clear evening occurred, in order not to spoil the parallax observations by leaving a gap of two months."

* * * * *

Sir Robert's Dunsink narrative proceeds:

The South dome stood on the lawn, about seventy yards from the door of the dwelling-house. It was in this building that I spent my nights when the sky was clear during the early years of my residence at Dunsink. The telescope was about eighteen feet long; the dome, which weighed six tons, was twenty-four feet in diameter. Inside the dome there was a moving shutter which had to be opened when the night's work was commenced. The dome, which was supported on wheels, could be easily made to revolve by mechanism on the inside, so as to bring the opening towards that part of the heavens where observations were to be made. My assistant had charge of the Meridian Circle, which was in a different place. It was in what was known as the Meridian Room, attached to the main building. It was my practice to work the South Equatorial entirely alone. I had no assistant to pull the dome round for me or to open the shutter. The fact is, that though sometimes the mechanical labour necessary was often considerable, it was not without its advantages. During the long stretches of moonless nights, when the temperature inside the dome was no higher than the outside—for there must be no heating apparatus in an astronomical observatory—it was often an advantage to have to move about a little to keep the circulation going. I have often been thankful that it was not my lot to practise astronomy in the United States. Writing to me from the Yerkes Observatory on April 17th, 1899, my friend, Professor Barnard, said: "It was below zero many nights of the winter, and for

several nights it was about 30° (F) below. I once worked all night when it was 26° below in the big dome."

Occasionally I would repair to the house to enjoy a cup of coffee prepared for me by loving hands. Sometimes I would pay a visit to the assistant at the Meridian Circle, or he would come and see me as the night advanced.* At first the long and lonely night watches in the dome were weird and uncanny, but this feeling gradually wore off. From the real dangers of my occupation in the South Equatorial I was preserved by some admirable advice given to me by Dr. Copeland—a man always fertile in resource. When I first proposed to undertake these solitary midnight vigils, he brought me over to the dome, and told me to try and foresee what accident might possibly happen at a time when I should be cut off from all chance of help, for there was no practical means of communicating with the house. He gave me several hints. I remember him saying, "In getting up on this step-ladder to wind this clock you have to put your arm inside *here*. If you slipped off the ladder while in that position your arm would be broken, and you would have no way of releasing it." We therefore arranged precisely how the step-ladder should be placed. One or two other precautions obviated dangers of a similar kind.

The machinery for raising the shutter, which was placed at a considerable height from the floor, was actuated by an endless rope passing over a heavy pinion. Dr. Copeland said: "That pinion is keyed on to the shaft, and on the shaft, of course, it ought to stay. But sometimes keys drop out, or get loose, when machinery is not properly overhauled, and if that happens the pinion will come down; and if you are standing beneath it, there will be an end of you." We therefore settled the exact position in which it was safe to stand when raising the shutter. I duly acquired the habit of standing in the right place, and during the eighteen years I was at Dunsink, although I raised that shutter hundreds of times, nothing ever

* Dr. Dreyer remembers these visits. On December 8th, 1913, he wrote to me: "I often think of the long chats I used to have with your father in the middle of the night when I looked into the dome on my way home. I often remained for half an hour, standing in the centre of the floor, while he sat on the observing ladder measuring stars for parallax. He was indeed a man whose interests were not confined in a narrow groove, but who had read and thought about a multitude of things. I have met very few people whose conversation I have enjoyed so much."—Ed.

happened. But Dr. Copeland's prediction came true. When I was using the South Equatorial—almost for the last time; it was just before I made the move to Cambridge in 1892—I was proceeding to close the dome, when the pinion fell with an awful crash. But it did not fall on my head. Fortunately for me I was standing where I always stood, not under the pinion, but in the place that Copeland and I had agreed upon some eighteen years before.

I often heard the hoot of the owl as he flitted round the observatory where I was working at the dead of night. I sometimes fancied that if only I could get that bird of wisdom to sit down beside me and put that wonderful eye of his to the great telescope, and tell me what he saw, I should have known all about the "Invisible Stars." Unhappily, owls don't care about the heavenly bodies; they only use those marvellous eyes of theirs for looking after "rats and mice, and such small deer."

A somewhat ludicrous incident which occurred during one of my lonely nights in the South Equatorial may be here described. It was in May, 1880. The night was very fine. The hours slipped away as rapidly as they were wont to do when I was engaged in the fascinating work of attempting to penetrate the wonderful depths of space. Not a sound from any human being had been heard for hours. About two o'clock in the morning the stillness was broken by a most terrific uproar. It came not from the fields around me; it seemed to come from under the dome in which I was working. It did not need much imagination at that hour of the morning and in my condition of absolute loneliness to make the incident somewhat alarming. I must confess I was terribly frightened. The din was such that it seemed as if a number of furies were hurling bricks at each other across the entire space under the floor. I felt, I must admit, very much inclined to bolt from the dome; but upon second thoughts I came to the conclusion that nothing would ever induce me to work there for another night unless I penetrated the mystery. The noise having ceased, I continued my work for another couple of hours. Having heard nothing more, I then closed up the dome and went across to the house. On the following day I procured a few tools with which to raise one of the floorboards in order to ascertain the cause of the disturbance. After a little investigation I found

out what had happened. The pier in the centre of the building, which supported the telescope, was founded on the rock, and a hole had been excavated to secure the necessary foundation. The floor was built with joists, in the usual way. It appeared that Dr. Brünnow, my predecessor, had suffered much from cold feet in his midnight watches. He seems to have thought that this was largely due to the draughts of cold air which came from outside and found their way through the interstices of the boards. Whether this was the reason or not, he had had a sort of ceiling made at the lower side of the joists. This ceiling had been covered over in the usual way with lath and plaster. In the course of years the joists had gradually become decayed, with the result that the attachment of the ceiling was weakened. It then occurred to me that on the afternoon of the day before this alarming incident took place, a large party of visitors—numbering, I think, sixty in all—came to visit the observatory. They were all in the dome together. No doubt their weight upon the floor had added to the strain of the ceiling on the joists. Why the ceiling did not immediately subside I do not know, but the ceremony appears to have been reserved for my special benefit at a time when it was well calculated to break the most iron nerves. Fortunately, the instrument was uninjured. A new floor had to be put in, but the airproof ceiling was omitted.

* * * * *

My father thus described the Transit of Venus in one of his lectures:

"The last Transit of Venus took place while I was at Dunsink, in the year 1882. To the end of my life I hope to treasure with peculiar interest the recollection of that beautiful spectacle. The transit had been timed to occur at 3 P.M. on the afternoon of December 6th, 1882. I need hardly say that at that hour on a winter's day the sun was very near setting, and of course it could be only a bare chance that the sky would be sufficiently clear to enable the phenomenon to be observed. On the previous day I went through, so to speak, a full-dress rehearsal by pointing the telescope to the sun and following it down to the position in which it would be, at the time of the transit on the following day. I then discovered, to my vexation, that the sun, on the eventful evening, would set directly behind a tree. It was plain that if the tree were allowed to remain standing, the Transit of Venus could not be observed from Dun-

sink Observatory. The tree was not under my control; it stood in a field belonging to Mr. Rathborne, a dear old friend and neighbour of mine. I knew that to do a kindness to me would be a pleasure to him, so I sent a note down to ask whether he intended to allow his tree to stand between the Observatory and the Transit of Venus. He asked me first whether I could not arrange for the transit to happen in some other place. I wrote again to say that even the Astronomer Royal himself could not manage that much. His answer was then a characteristic one. He sent out his men and levelled the obnoxious tree forthwith.

"On the eventful morning the ground was white with snow. The snow continued to fall all the forenoon, and there seemed but little prospect that the sun would be visible at the required time. But I got everything in readiness, and the telescope was pointed to the sun—or, rather, I ought to say to the spot in the heavens where we knew the sun was, for the sun itself could not be seen through the thick clouds. The critical moment arrived when we knew that Venus must have touched the sun. Not a glimpse had been seen, nor was it likely that we should see anything. But just as I had begun to despair, an almost miraculous improvement took place in the weather. The sky lightened, the sun burst forth behind that very place where the tree had stood the day before, and then, to my delight, I beheld the globe of the planet Venus standing out on the solar disc. The beauty of the scene, the knowledge of its rarity, and the interesting associations connected with this Transit of Venus, impressed me deeply. But presently the sky became overcast, the snow came on again, and the phenomenon drew to a close—a phenomenon which will never be witnessed again by any human eye until the flowers are blooming in June of the year 2004."

It was the practice of the Board of Trinity College to visit the observatory once a year. They inspected the buildings and the instruments, and received the annual report of the professor. Their proceedings were recorded in the Observatory Book. I often had intended to make a copy of this book. It contained much that was interesting and much that was amusing. In particular it contained the history of two clocks, which, at a much later date, I ventured to relate to the graduates of Trinity College who were assembled at a dinner in London. It was shortly after the opening of the Graduates Memorial building in Trinity College. I was endeavouring to point out that in Ireland things were generally done in a leisurely

manner, and the following is a note of what I am reported to have said on this occasion:

"It was in 1793 that the Board recorded in the minutes their resolve to have two observatory clocks sent to Crosthwaite, an eminent Dublin clockmaker, for repairs. I cannot follow their history in all its details, 'not through each devious path, each changeful year of existence.' I must rather strive to give pictures from time to time of the thoroughness of the way in which Crosthwaite undertook his work, and of the splendid resolution with which the Board of the period dealt with the successive exigencies as they arose. The clocks were sent in 1793. After seven years, in 1800, I find that Crosthwaite was asked whether they were ready. It is quite obvious that the Board of 1800 must have contained some impatient and inconsiderate member who had urged this precipitate action! That it was wholly unreasonable to expect the clocks to be repaired in so short a time as seven years was clearly proved by the fact that even four years later—in 1804—we find that they were still in Crosthwaite's hands. In 1806, the clocks not having been yet returned, the Board, in their wisdom, felt that the moment for decisive action had at last arrived. They went so far as to instruct the Bursar to call upon Crosthwaite. This determination, inexorably carried out, was attended with the most gratifying success—so much so that when the Board met at the Observatory one year later—in 1807—the report of the Royal Astronomer conveyed the welcome assurance that he had no doubt whatever that the clocks would be speedily returned. Eight years later—in 1815—one of the clocks was still in the hands of Crosthwaite, this most careful clockmaker, and so it was in 1816! That, I greatly regret to say, is the last record we have of these interesting timepieces. Astronomers are, however, accustomed to deal with such vast periods in their calculations that even the time taken to repair a clock seems but small in comparison!"

It was while I was at Dunsink that I first became acquainted with royalty. I have twice had the honour of being in the company of the late Dom Pedro II., the Emperor of Brazil. On the first occasion the British Association were holding a meeting in Edinburgh. One evening a large number of the members were present at a reception given by Sir Wyville Thompson, whose name will ever be remembered as the naturalist in charge of the famous *Challenger* Expedition. The party at Sir Wyville's was in full swing, when the butler came into the room with a face expressing much consternation. He

called Sir Wyville out and said that a real Emperor, with two or three attendants, had suddenly presented himself at the door and demanded admission. Those who recollect the extraordinary rapidity of Dom Pedro's movements, and the unexpected way in which he suddenly turned up at all sorts of places, will not be surprised at this incident. Sir Wyville hurried down, and was immediately addressed by the Emperor, who spoke in French. His Majesty announced that he had come to spend a few hours in Edinburgh, and that he desired to see something of the British Association. He then said: "On my arrival in Edinburgh I made inquiries as to where the leading men of science attending the meeting were to be found at that particular moment. Having been told they were at Sir Wyville Thompson's, I at once said that I had heard of Sir Wyville's reputation as a zoologist, and that I would like to make his acquaintance at that very moment; and so here I am." He was duly ushered into the drawing-room. A few of the more illustrious people present, of whom I was not one, were introduced to him. He stayed about half an hour, and then departed in a great hurry, saying that he had to visit two or three other places before he considered his evening closed.

The date of my next meeting with Dom Pedro was in 1876, about the time when Mr.—now Sir Howard—Grubb was constructing an equatorial for Vienna. The object-glass of this instrument was over two feet in diameter. To make such a large telescope is no light undertaking even at the present day, but at the date of which I am speaking it was almost unique. At the time the object-glass was almost finished, and the instrument generally was in a very forward condition. Astronomy was one of a thousand subjects in which Dom Pedro took a very lively interest. It was his habit to map out his time most carefully, so that whenever he visited any city he might be able to see everything he wanted to see with the least possible delay. In order, I suppose, to save time he wholly disregarded formalities, and studiously avoided ceremonial functions of every description. In true kingly fashion, he compelled everyone to fall in with his ideas. He took possession of each place he came to as if those he visited were his subjects; and as if he were an arbitrary ruler. But his was the rule of a kindly monarch. Those whom he visited never bore malice;

Photograph by Wm. Lawrence, Dublin

DUNSINK OBSERVATORY, CO. DUBLIN

indeed, they enjoyed many a laugh at the magnificent manner in which he accomplished his protean sightseeing.

It was known in a general way that the Emperor was about to visit Dublin. One fine morning he landed in the North of Ireland. By dint of a tremendous effort he visited the Giant's Causeway and a number of places in Belfast during the early part of the day. He then took a special train to Dublin, where he arrived late in the evening. He at once proceeded to Guinness's Brewery; after which he inspected another large factory in another part of the town. Finally, he attended a performance at the Gaiety Theatre. On returning late at night to the Shelbourne Hotel, he sent for the Lord Mayor.

When that dignitary arrived, ready to place the whole resources of the city at His Majesty's disposal, the Emperor at once cut conversation short by saying that his particular object in coming to Dublin, was to see the great telescope which was being constructed by an instrument-maker in Dublin of world-wide celebrity. "I cannot," said His Majesty (who, by the way, had learnt to speak English exceedingly well since his visit to Edinburgh), "I cannot remember exactly the name of this great man of science, but, of course, you know whom I mean." The Lord Mayor looked at his secretary, and the secretary looked at him! They were both at a loss. The Chief Citizen of Dublin then hazarded the name of a worthy spectacle-maker who lived near by, but the Emperor at once pooh-poohed that notion, saying that the name of the man he was looking for was something like "mub" or "tub." This hint failed to produce any effect, and the Emperor expressed his surprise that a man who called himself Lord Mayor of the city should be so ignorant of such an elementary matter. "At all events," he went on, "you must find out for me in the course of the night where the famous optician is, and take me to him to-morrow morning." By this time it was twelve o'clock on a Saturday night. The Lord Mayor and his secretary returned to the Mansion House, where I have no doubt they spent an anxious hour in considering how they could extricate the reputation of the city from the obloquy which Dom Pedro was inclined to cast upon it. Suddenly it was remembered that there was a person in the vicinity of Dublin known as the Astronomer Royal. Although I don't suppose they imagined that that humble individual was the person whom the Emperor wanted

to see, yet it occurred to them that it was within the bounds of possibility that the Astronomer Royal might know whether in fact there was an eminent optician in Dublin. To consult him might be to find a way out of the difficulty. I was at that time Astronomer Royal of Ireland. Once or twice I had said, half in jest, to my wife that when the Emperor of Brazil came to Dublin he would probably pay us a visit at Dunsink. So we had the Emperor somewhat on our minds. At about eight o'clock on the morning of Sunday I heard the sound of wheels on the avenue. For any vehicle to arrive there at that hour of the morning was rather unusual, but when I looked out of the window I was truly astonished at the apparition. There was the Lord Mayor's coach and pair driving up the avenue! I came down at once. The Lord Mayor's secretary rushed in to tell me of the terrible anxiety under which his chief was labouring. He asked me whether there was any truth in the suggestion that some very big and famous telescope was being made in Dublin for Vienna. I replied that I did happen to know something about the matter; that, indeed, I was one of the committee to whom the general supervision of the work had been entrusted. He then begged me to come to Dublin at once, and forthwith to take the Emperor off to see Grubb and the telescope. I said, "Grubb's place will be shut up as it is Sunday." The agonised secretary replied, "Oh, the Emperor cares nothing about that, and we must do what we can." So there was nothing for it, but for me to go to Dublin and breakfast with the Lord Mayor, while we sent off messengers to Mr. Grubb at Rathmines, telling him of the visitation with which he was threatened, and imploring him to collect a few of his hands so as to open up his works as far as possible. I then sat down to await the convenience of His Majesty. As I ascertained a little later, he had already begun a truly colossal day of sightseeing. At some unearthly hour of the morning, he visited the Botanic Gardens at Glasnevin, the Model Farm, and one, if not both, of the two great Dublin workhouses. Then he attended Mass at the Carmelite Church, in Whitefriar Street, and took a drive of eight miles round Phœnix Park. It was not until these items in his programme for the day had been ticked off that he was ready to receive me and to hear what I had to tell him about the telescope. I forgot to say that before seeing me he had also paid a visit

to Trinity College and its museum. In the museum he refused to look at anything except objects of special Irish interest, with which he had already made himself acquainted, namely, the superb collection of prehistoric flint weapons for which the museum is famous; and I was told that when passing a case of stuffed animals he observed that the ant-eater was a fellow-countryman of his.

When we arrived at Grubb's we found the famous telescope-maker waiting for us. He had succeeded in getting together a few of his exceptionally skilful workmen. At once the Emperor showed himself thoroughly informed on all matters relating to the great object-glass. He was also well acquainted with the particular requirements of the Vienna telescope. In accordance with his usual custom, he declined to look at anything which he had not decided would be worth his time. When he bade Grubb good-bye an amusing incident took place. His Majesty, though so well furnished intellectually, was, to put it mildly, by no means conspicuous for the regal splendour of his attire. As he was leaving he took up what he no doubt supposed to be his hat. In reality it was a beautiful new "Lincoln and Bennett" belonging to Grubb. The Emperor had left behind what we call in Ireland "an old cawbeen." He was on the point of stepping into his carriage when the secretary, who was evidently accustomed to these little lapses on the part of His Majesty, effected the necessary exchange of head-dress! I had noticed that, while the Emperor had driven up with his secretary in one carriage, an empty vehicle had followed behind. The object of this I did not know at the time. But when we were leaving Grubb's, Dom Pedro shook hands with me, and pointed to the empty carriage, saying: "That is at your disposal for any purpose whatever." As he was calling out to his coachman to drive to the College of Surgeons, we separated. I did, however, get one further glimpse of his carriage later in the day, when I was returning to my home at the Observatory. The Emperor had, of course, been hard at work all the afternoon. In fact, the day's sightseeing he accomplished was, I believe, unparalleled. It included three distinct drives in the Phœnix Park, with innumerable visits in between. I saw his carriage driving up at last to the station, while two fat horses drawing the Lord Mayor's carriage were taxing all their energies to

keep up with the Emperor. When he arrived at Kingsbridge Station he had a quarter of an hour to wait. "Oh," said he, "there will be just time to see the Royal Hospital." A diligent study of the map had shown the whereabouts of this establishment. Off he went up to the hospital, which I believe at that time still contained two or three Waterloo veterans. By the time he returned to the station it was well past the hour of starting. At last he and his retinue took their seats. The stationmaster appearing to be somewhat embarrassed, someone asked him why he did not start the train, which was already late. But he said there was just a slight difficulty—a little technical inadvertence. The Imperial party had not paid their fares. This was pointed out to the worthy secretary, Don Retero, who, with a thousand apologies, at once made the matter straight. And the Emperor at last went off to Killarney, having during his twenty-four hours in Dublin achieved a record in sightseeing.

What I saw of the Emperor in Dublin created an impression which was confirmed by what I remember hearing of him elsewhere. He made up his mind to see every important man of science, and every important institution or manufactory that could be encompassed in his tours. He steadily scorned any inducement to spend a moment of his time on what he conceived to be less worthy objects. He was an early riser, and thought nothing of sending a message to Sir Richard Owen or to Sir Joseph Hooker to say that he intended to call on them at six o'clock the next morning. He had not many more years of sovereignty in Brazil. A revolution—happily a peaceful one so far as he was concerned—took place, and he retired, to spend the few remaining years of his life in intellectual pursuits, without the cares of a kingdom. He seemed to have inspired nothing but friendly and cordial feelings in the minds of all who came across him in Great Britain.

Among my neighbours at Dunsink, Mr. John G. Rathborne deserves special mention. He was one of the best friends I ever had, and the walk home from Castleknock Church on Sunday mornings was always rendered delightful by his company.

I would like here to set down the last letter we ever had from him. He was then suffering from an incurable malady, which three months later proved fatal. My wife had sent him

a little Christmas token, and here is his reply (December 31st, 1894):

"I really cannot find words to express my gratitude for your very kind letter and the book you sent me, which I value very much. I also received a letter from my beloved friend Sir Robert, and feel that it is just the letter I would like to write to him, feeling sure that such love will never end. Wishing yourself, Sir Robert, and your charming family a happy and prosperous New Year, and many many happy returns."

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The autobiographical part of this chapter may be suitably brought to a close by the final passage of the last report which my father made to the Board of Trinity College. It was dated June 30th, 1892:

"Before closing this report, it is my duty to notify to the Board that last February I accepted the Lowndean Chair of Astronomy and Geometry at Cambridge. Since this I have been appointed Director of the Cambridge Observatory, and have received a Fellowship at King's College.

"I am sure the Visitors will readily believe me when I say that it is not without many painful feelings that I contemplate the severance from so many cherished associations which my acceptance of these new duties will involve. Eighteen years have elapsed since the Board committed to me the charge of Dunsink Observatory. Since then my relations with the Board have at all times, I am glad to think, been of the happiest description. I recognised in them not merely my official superiors, but my warm personal friends.

"I am glad to think that I shall leave the observatory in a high state of efficiency. During my time the electric chronograph has been added, the clock control system has been organised in a very effective manner, and Mr. Roberts' splendid gift * has now added what alone was wanting to place our observatory in the very forefront of similar institutions, so far as equipment is concerned. To the maintenance and improvement of the establishment generally, inside and outside, I have also devoted much attention, and I shall presently request the attention of the Board to a separate communication bearing on the matter. Let me add in conclusion the expressions of my sincere good wishes for the future of Dunsink, in which beautiful home I have passed the busiest and the happiest years of my life. As this must be the last occasion on which

* A reflecting telescope of 15 in. aperture.

I shall have the honour of receiving the Visitors, I bid them a heartfelt farewell."

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So much for his own record of the life at Dunsink. Before he went there he had consulted Professor Adams, whom he was to succeed at Cambridge, as to a line of research. The Professor wrote as follows (July 14th, 1875):

"I hope you will pardon me for having taken so long a time before sending a reply to your letter, but I wished to give some consideration to the subject before replying, and just after your letter arrived I was called away to London, and thus prevented from giving any thoughts to it for more than a week.

"Of all the subjects which you mention, I think that the Theory of Jupiter's Satellites would be most likely to repay for additional investigation. M. Souillart has published an essay on the subject in *Tome* 2 of the *Annales Scientifiques de l'Ecole Normale Supérieure*, in which he treats the problem by the method of the variation of the arbitrary constants; but I do not see that he has added anything to the theory of Laplace. The tables of Damoiseau also do not accord well with observation, and are not quite satisfactory from a theoretical point of view, if I rightly understand his introduction.

"This subject, however, will require a very considerable amount of labour.

"The Theory of Precession and Nutation is also a good subject to take up, though more has been done in it since Laplace than in the above subject. For this you should consult Peters' *Numerus constans Nutationis*, and also Poisson's Memoirs in the *Journal de l'Ecole Polytechnique*, and in the *Mémoires de l'Académie des Sciences, Tome* 7, and likewise the memoir by M. Serret in the *Annales de l'Observatoire Impérial de Paris, Tome* 5. A kindred subject, though not in your list, is the Theory of Libration of the Moon. It is true that this theory may be already considered to be complete, through the labours of Lagrange, Laplace, and Poisson, but it would be highly desirable to redetermine the coefficient of the principal term of the real libration in longitude, by more numerous observations than are employed by M. Nicollet in his memoirs in the additions to the *Connaissance des Temps* for 1822 and 1823. It would be interesting also to find whether observation shows any trace of those arbitrary terms in the libration which depend on the initial circumstances.

"The Theory of the Satellites of Saturn would form an excellent subject of investigation, if there were not an almost

complete deficiency of observations with which to compare the results of the theory. Bessel has done something towards the theory of the sixth satellite in the ninth volume of the *Astronomische Nachrichten*. If what I have said above helps you at all in making up your mind what problem to attack, I shall be very glad."

Sir Joseph Larmor has written the following recollections of my father at about this period:

"My first acquaintance with Sir Robert Ball dates from the early 'eighties, when, as Professor at the Queen's University in Ireland, and subsequently as Examining Fellow at the Royal University, I used to spend several weeks each year in Dublin. The way in which I was made free of Trinity College and welcomed into the intellectual circle of the University is one of my most pleasant recollections of those days. The Fellows and Professors were a body small enough to form an organic society, keenly interested, after the usual manner of Irishmen, in each other's pursuits and activities. Although many of them were recognised authorities in special branches of knowledge, it seemed to be impossible for any one to remain content to turn his solitary furrow without coming into contact with the personalities and intellectual work of his colleagues. This community formed a recognised part—indeed, it was almost the centre—of a larger society which included the Bench and Bar and the learned professions of Ireland, and not a few of the Irish country gentry who maintained a lifelong devotion to their University. Thus leavened from without, the Fellows and Professors did not become absorbed in details of academic administration, while the national sense of humour saved their visitors from being overawed by the presence of intellectual authority. The general company would freely take part in the discussion of subjects in which they could not pretend to be more than amateurs. The breadth of substantial attainment amongst the men who moved in this circle was remarkable, and the stimulus resulting from contact and comparison between adjacent sciences was often most conducive to the progress of special branches of knowledge.

"It was with such an atmosphere that Robert Ball was surrounded from his early years; and he thoroughly imbibed that full flavour and zest peculiar to Irish scholarship, which subsequent residence in England never diminished. After

morning chapel on Sundays his college friends would walk to the observatory at Dunsink, through the exquisite scenery of the Phœnix Park, to meet, at or after lunch, other pilgrims from Dublin, or public men resident in the neighbourhood. Whether expected or not, these visitors never disturbed the even and ample flow of Lady Ball's hospitality. Among them I recall George Francis FitzGerald, who was then still living in college. He represented to a great extent the tie which connected the exuberant activities of the younger Trinity with the sympathetic but more sedate ideas of the Senior Fellows. By his perfervid genius he was then rapidly attaining a position of authority and influence in British physical science, in which his premature decease was to leave so large a gap.

"Between Ball and FitzGerald there was a strong tie of common intellectual interests. Both were stirred by the same deep, not to say romantic, curiosity about the intimate modes of evolution of natural agencies. Each managed to combine a wide field of view, which might have been a dissipating influence, with profound attainment and luminous thought in his own special department. The conversation at Dunsink would sometimes wander to the personal traits and character of Sir William Rowan Hamilton, Ball's greatest predecessor as Astronomer Royal of Ireland. The subject of Irish archæology was never far away, stimulated, as it was, by the famous and magnificent collection of the Royal Irish Academy, now deposited in the National Museum of Ireland. I can remember Ball relating, with a glow of enthusiasm, how, when calling on an eminent physician who was also an archæologist, he would sometimes be taken into an inner sanctum to discuss the national significance of some antiquarian relic, while the patients, who flocked to consult the medical specialist, had to be informed that he was engaged!"

During the earlier years at Dunsink, my father had many difficulties to contend with. The salary was small, his family was increasing, and the amenities of the place were not such as to relieve him from anxiety. One of these difficulties was to secure an adequate supply of water, the only source being a very deep well in the yard. A glimpse of the early life may be obtained from the following letter to his sister, Mrs. Thomson (August 11th, 1874):

"We are beginning to get settled. Price came yesterday and put up blinds, Jones comes to-day to put up curtains, and Millar and Beatty to-morrow to put down carpets. The cow is grazing on the lawn (she kicks when being milked!), the horse (he has an obstinate cough) is comfortable in the stable, and the ancestors smile on us at meal-times as heretofore! F. likes the place, and takes a great interest in various small matters connected with the garden, etc., particularly in the ripening of a swarm of *Magnum Bonum* plums. Robin is well, and Sis is jubilant, but was in great grief the other day from the sting of a wasp, and more so I think from the boiling water which the nurse applied as remedy! I have not yet cultivated the other child, but from the reports I hear I believe he is alive and well. Mr. Rathborne has given them the run of his fields, which are much pleasanter than ours for such a purpose. For my own part, I love the place and the work more and more, and am thankful that my lines have so fallen. The only thing I miss here (if I am still to grumble) is what you have so much of at Waterville—*water*. I don't fly so high as the sea or a lake or a river, but I would like a pond or a stream, or even a good ditch."

It may be of interest to give some account of his private life at this period. Such notes, however, are limited by the fact that they are made by one whose memory does not go back very far.

I remember my father in the Dunsink days as a strong man who worked with unremitting zeal—often both night and day. When his parallax work kept him up half the night, he would toil during the day at his mathematics ("sums," as we children used to call them) and at his books. My earliest recollection of his work in the observatory dates back to 1882, when the Transit of Venus took place. I was told off to carry out lunch to the dome, where the South Equatorial was exposed to the wintry sky. I duly performed my mission, to be rewarded at the end by a peep through a tourmaline lens at the orb of day!

My earliest recollections of his literary life date from the preparation of "The Story of the Heavens." He was suffering from lumbago at the time, and I remember him lying at full length on the floor of his study, as that was the only position in which he could write with comfort. From year's end to year's end he never seemed to think it necessary to take a real holiday.

It must be confessed that a succession of fine nights was

not a source of gratification to us children. They involved the absence of our chief playmate; for he often took a prominent part in our games. He would sometimes assume his observatory costume, and appear in our midst as a brown bear. More often he would tell us stories of his own invention—stories which ran on from evening to evening. But perhaps he pleased us best when he drew upon his large store of miscellaneous scientific knowledge. On countless occasions we enjoyed the magic lantern, the smoke ring box, and the art of making gunpowder and Bengal fire.

He taught us two games which were always very popular. The first was a species of cock-shy. A number of well-corked empty bottles were procured. Armed with these, we would go to the banks of the little river Tolka. A bottle would be thrown into the stream, and the game was to hit and sink it when carried along by the current. The other game was founded upon something which he told us after a sojourn in Holland. He explained a device which was adopted by farmers who keep ducks in that watery land, in order to bring the birds home to the farmyard in the evening. The farmer's wife would ring a bell, at the sound of which every bird would hasten home with all possible speed—urged on by the knowledge that the last duck to arrive would be soundly beaten! One of the young people was told off to act as the farmer's wife, armed with the dinner-bell. Upon its being sounded each and all would hurry to the rendezvous, and woe betide the one that was last!

Many a time did he hold us enthralled by his conversation at table, touching with the skill of a master upon the current events of the day, explaining and expounding all sorts of subjects. As anyone who has read his books or heard him lecture is well aware, he was by no means a man of one book or one subject. He could talk of much else besides astronomy, much else of a scientific or quasi-scientific character, which he could present in delightful form to the mind of youth. Botany, zoology, geology, engineering—upon all these great studies he could answer questions which children are wont to ask. Long after the table in the old dining-room at Dunsink was cleared we would sit to absorb instruction, not recognising it to be such. Nor did he merely play the part of a man of science; political economy was one of his early

studies, and he could explain it by the hour. Last but not least, his perfectly amazing memory for all the events of his early life supplied him with a vast fund of incident and anecdote which made a strong appeal to the imagination.

My sister-in-law, Mrs. Robert Ball, the mother of Stella and Robert ("Robin"), writes as follows:

"His love for children and his capacity for amusing and interesting them soon found a way to their affections. He delighted in that quick response which a child gives to sympathetic interest in its little pleasures.

"He was devoted to his grandchildren* and they to him, and was never too busy or too absorbed to see them. If one of them happened to trot into his study when he was deep in mathematics, he would turn round at once and with his welcoming voice call out: 'Ah! is that you, my dear?' The papers would then be pushed aside, and, sitting on Grandpapa's knee, the little visitor would be entertained by him in his inimitable way.

"In the early stages of his last illness, when they ran up to his bedroom to kiss him 'Good morning,' he would not let them leave without inviting them to thrust their hands under his pillows to see if by any chance some packet of chocolate had not become wedged into the hollows. His simple goodness appealed even to their youthful minds, for on one occasion when they were listening to the history of the patriarchs, Robin (then aged 4½ years) inquired: 'Was Abraham as good as Grandpapa?'"

His experience of horses was anything but satisfactory; indeed he met with so many disasters that he used to say the horse was one of Nature's mistakes. On one occasion he had returned with my mother, late at night, from some festivity in Dublin. Shortly after they retired the coachman rushed in to announce that the mare had overturned the brougham in the yard! Nor were his experiences with cows much more satisfactory. In summer the feeding of the cows was a simple matter, inasmuch as the grounds attached to the observatory included several acres of good pasture. In winter, however, their diet had to be supplemented, and they were regaled on a

* The names of his grandchildren are: Stella Elizabeth Ball, Robert Sturge Ball, Harold Stawell Ball Meakin, Henry Barcroft, Robert Ball Barcroft, and Peter Halley Ball.

delicious viand known as cotton cake. The gardener—who acted as cowherd in his spare time—had never heard of this substance before, and did not believe in it. Moreover, he was profoundly ignorant of the quantity which should be administered. In the result his master provided him with a scales, and prescribed so much *per diem* for each animal. Notwithstanding these precautions, the "fodder" disappeared at an appalling rate. I well remember hearing the gardener being upbraided for his extravagance. His reply was:

"Ah! Sir Robert, that cotton cake is very heavy stuff. A pound of that weighs more nor a pound of hay!"

My father tried various experiments with artificial dressings for the soil, e.g. bone meal, and superphosphates, nitrates, basic slag and the like. This treatment of pasture land was comparatively new in Ireland in those days, and was viewed with suspicion and distrust by all the neighbouring farmers until the results were made manifest. It was therefore with great delight that he received a visit from the steward of a large estate close by, who inquired of him where he had obtained the material which produced such a magnificent crop of hay.

He tried smoking when he was thirteen, but he abandoned the practice after he had nearly finished his first pipe and never resumed it. He took stimulants with great moderation. At one time he thought of becoming a teetotaller, not (as he wrote to his sister, Mrs. Millington, on December 2nd, 1880) "for any noble motives." He announced (in the letter referred to) that he wished to take the pledge because "The fact is I find that I (like, I believe, most other people) do not require strong liquors, and am better without them. Hospitable people are often pressing me, and to save trouble I take sometimes what I would really much rather be without. A teetotaller cannot be pressed, and people will not bother him. To me it will be a gain of liberty and not a sacrifice."

He was always fond of dogs. The first that I can remember was a retriever which bore the name of "Grouse." He used to tell us that the very day after he purchased this animal he took it for a walk to Dublin (a distance of about five miles), when the dog got lost. Upon returning home late that night Grouse met him on the doorstep, having found his way back by a route which it had only traversed once. Another dearly beloved dog was a collie named "Focus," which accompanied

the family from Dublin to Cambridge, where it lived for many years. The demise of "Pat," a fox terrier, another Cambridge favourite, is referred to in a letter to Mrs. Millington (May 6th, 1908):

"I am just engaged in breaking into decent behaviour a new house-dog, 'Taffy,' the successor of 'Pat.' Pat, after a happy life with us for ten years, has died of *Anno Domini* (with the help of a little assistance), poor chap."

While he was Astronomer Royal of Ireland my father established a custom which endeared him to the hearts of the undergraduates of Trinity.

Elementary astronomy was one of the subjects for the ordinary degree, and he used to give a course of lectures in college. He was not, however, content with abstract teaching. He afforded the students an opportunity of seeing the instruments at Dunsink, where he was able to point out their practical application to the science of astronomy.

On four successive Saturdays in the spring, parties of students were invited to the observatory. After a morning demonstration they were regaled at lunch. My childish recollection of these entertainments is associated with a huge silverside of beef and an enormous bowl of Normandy pippins, which formed part of the accustomed fare; and I well remember the sound of the cheers which were given for the Professor when the students took their departure. In his journeyings up and down the world, Sir Robert used to say that he often met old students of T.C.D. whose names and faces he had long since forgotten, but who remembered their visits to the observatory. The elements of astronomy may have faded from their recollection, but they remembered the genial hospitality of their kindly mentor!

After he moved to Cambridge the instinct of hospitality to the students remained with him to the end. Aided and abetted by him, my mother would hunt up the names of my father's friends who happened to have sons or nephews at the University, and never a Sunday passed without a number of students being invited to lunch. Even the most timid undergraduate was soon at ease in his presence.

It was in the year 1883 that he first began to have serious trouble with his right eye. He consulted Sir W. Bowman, who prescribed dark glasses and rest for the eyes, but though he

held out some hopes, he was not sanguine about being able to restore the bad eye perfectly.

Those were not the days of celestial photography, and practical astronomy put a severe strain upon the sight. My father was sorely troubled by an affliction which threatened to interfere with his life's work.

Notwithstanding the care and attention of Dr. Storey and Sir William Bowman, the bad eye grew worse, and he eventually lost the sight of it altogether. But he bore this trial with characteristic fortitude. Writing to Mrs. Millington, he said:

"I have grave anxieties, but they are largely, if not quite, counterbalanced by a calm feeling of thankfulness that I have been permitted to use my eyes for so long, and that the trouble has come at a time when 'rest' does not seem so disastrous as it would have done ten or five or even two years ago. I have kind masters who will, I feel sure, remember that I worked hard when I could work, and that I have brought some credit to my old University. I have no literary engagements which I cannot fulfil. My book ('The Story of the Heavens') has long been out of my hands, and perhaps this dispensation has come to prevent me from reading the reviews! Besides, a mathematician has resources which no one else can understand. It is no tedium, but rather a lofty delight for me to sit by the hour and think of deep matters. My chief anxiety is not at all for myself, but for those dependent upon me. The tenderness of wife and children has been inexpressibly dear to me. I have, however, no anxiety, or, at all events, very little, about the good eye. It is a perfect one at present, and I see none of the phenomena there which have been in the other for so many years."

He was a voluminous reader. It sometimes amazed me to hear of the number of books he had read, and his accurate memory enabled him to speak of them long afterwards. Nor was his reading confined to scientific matters. He loved books of travel; and when the shelf containing the Mudie books was replenished the newest works of travel in all parts of the globe were always to be found there. He said that "The First Crossing of Greenland" was the finest of Nansen's works. But his literary tastes were catholic. I found him one day reading "The Stones of Venice." "Yes," he said, "I like imaginative things." He also delighted in history. He had read Alison's "History of Europe" three times. Modern fiction he did not care for, but he loved Dickens and Thackeray. He knew "The

Pickwick Papers" from cover to cover, and could quote long passages without omitting a single word. He also knew and often quoted Thackeray's "Book of Snobs," and he loved Jane Austen. Among Mark Twain's works he always chose "Life on the Mississippi" for special mention.

He was always anxious to illuminate his lectures on astronomy and kindred subjects with practical information of all kinds.

In 1881 he wrote to George Francis FitzGerald for information with regard to tidal effects in comets. He received the following reply (October 31st, 1881):

"I cannot see how tides can have much to do with comets' tails. Of course, they would tend to distort the comet, and somewhat unsymmetrically. If there were no rotation of the cometary mass on itself, it would be drawn out towards the sun, and rather more on the side next the sun than away from it. If the cometary mass have rotation, the matter is, of course, much more complicated, but if Newton's investigation holds at all in this extreme case, there should be a tendency to flatten towards the sun, and there seems no evidence of this. Besides, I thought that Newton (?), of America, had shown that parts of the tail moved as if under a force directed towards or from the sun only, and I further thought that he had shown that it was like a repulsive force, and no rotation or tides could bring out such a result. It seems likely that the cometary attraction controls the motion of the tail little, if at all, and if we may neglect it, the effect of rotation is comparatively easily calculated, for the different parts of the mass go on their way in separate orbits, and as far as I can see the effect is to draw out the comet at right angles to the direction of the sun.

"The only theory of comets' tails I know is one founded on Clerk Maxwell's result that 'radiation should repel.' If the molecules be of large enough area compared with their mass, they will be repelled instead of being attracted by the sun. If any observations of the deformation of a comet's tails by a cold body could be got at, it would settle the question as to whether it were attracted by it, and so whether the repulsion were due to the sun's being hot. I don't know whether the great comet which ran into Jupiter developed a tail during the passage, or whether the passage was seen at all; but if it did not, I think it would have to be acknowledged that the development of tail was due to the sun's being hot. Of course, the only effect of this might be to volatilise the cometary matter, but the development of a repulsive force seems another possible consequence.

"I was vaguely aware that some doubt had been thrown on

the resistance of Encke's Comet, and I am glad to hear it has been quashed. What I wrote to you shows that a combination of a velocity propagation of gravity and a resisting medium could not counteract one another's effects on a comet, though they might on a planet, and so removes both hypotheses—which is a very much to be desired consequence—from physical astronomy.

"I once calculated the size of the molecules in order that they might be neither attracted nor repelled by the sun, according to Maxwell's theory, and if you like I will look it up. The earth may have a tail, as some suppose, and it would be odd if it had not, unless all the matter that is so large, moleculed in proportion to its mass, has been repelled out of the solar system long ago, and only returns from the cold abysses of space in the train of comets. Though no *atoms* may be so large, yet some *molecules* may, and the evidence seems to be that the comets' tails are hydrocarbons; and if the right kind existed on the earth, and near the limits of the atmosphere, so as to get the full force of the solar radiation, it would make a little tail to the earth.

"I dare say you recollect Stoney's theory as to the light from comets' tails. He thought it might be a case of selective reflection, and according to Stokes's theory of selective absorption there ought to be selective reflection, too—or rather selective diffusion, which is what Stoney wanted. The solar vibrations of a particular period are taken up by the gas, and it is set in vibration primarily at that period, and, if there are not many impacts, there is reason to suppose that each molecule will go on vibrating at the intensity it is set going with until it has radiated its energy all round. It is then absorbing vibrations from the sun and giving out the same all round. Stoney tried some experiments to try and verify this theory in the case of light diffused from iodine vapour, but the results were not very satisfactory. The only similar effect is fluorescence, and why cold gases should not be fluorescent I can't see. On the whole the theory seems sound, and I am intending to try some further experiments on the vapours of fluorescent hydrocarbons.

"I think I have told you all I have ever surmised about comets, and hope it may not cause you nausea."

He was always on the look out for poetical quotations with which to adorn his lectures and his writings. In April, 1877, Professor Edward Dowden wrote to him:

"Milton (who saw Galileo in prison) planned his poem on strictly Ptolemaic doctrine, but really *inclined* to believe the Copernican true. This is all admirably discussed in Masson's preface to his new edition of Milton.

"Two passages in 'Paradise Lost' show his inclination to Copernican Astronomy (*see* Book VIII., 123, 899, and Book IV., 592-597).

"But in Book VIII., 90 and 99, there is a defence of the Ptolemaic theory against objections. For diurnal motion of sun see Book V., 171-179. Sunset, Book VIII., 630.

"The crystalline spheres and *primum mobile*, Book III., 481-483. But I can't find—though the idea is so familiar—any passage telling of Adam's feelings at the first setting of the sun.

"The following fine sonnet of Blanco White, which Coleridge called the finest sonnet in the English language, touches on the idea you want:

SONNET ON NIGHT

'Mysterious Night! when our first parent knew
Thee from report divine, and heard thy name,
Did he not tremble for this lovely frame,
The glorious canopy of light and blue?'

"I don't think I need copy more, for the rest is not to the point. It is given in Trench's 'Household Book of English Poetry.'"

On March 9th, 1882, my father received a characteristic letter from Lady (then Mrs.) Huggins, announcing that she and Sir William Huggins had succeeded in photographing the spectrum of a nebula:

"You may remember that when we had the pleasure of seeing you here about Christmas, and we were talking in our library, I bewailed to you the non-success of our efforts to get a photograph of the spectrum of a nebula. As I *lamented* to you, I cannot deny myself the pleasure of telling you that on Tuesday night (7th) we *succeeded in getting a photograph of the spectrum of the Great Nebula in Orion.*

"My husband sent a paper giving results of examination of the photograph to the Royal Society yesterday. I was very busy helping him, or I should have sent you a line sooner, for I think you will be interested. You shall have a paper as soon as possible.

"What delights me very much is that our photograph is so far satisfactory, that with longer exposure than we were able to give the other evening (owing to clouds coming up) we may, I think, hope for even better photographs of the Great Nebula; and even to succeed in getting photographs of the spectra of other nebulæ. A series of such photographs could hardly fail to add to our knowledge. But I need not tell you there are many difficulties both as regards conditions and as regards

operation in any such work, and perhaps we may never be able to do much more.

"Tuesday night was almost the only night during the last three years we have had clear enough to give much chance of success with a nebula, and even then we were hindered by clouds coming.

"Pray pardon me if I have too much intruded on your time.

"My husband and I unite in very kind regards to you. We have not the pleasure of knowing Mrs. Ball, but I trust she will —in a scientifically prospective spirit—appropriate some of the above kind regards.

"Such appropriation, I am sure, should be looked upon as a most reasonable exercise of Woman's Rights! Some day, no doubt, Mrs. Ball will come to London with you, and then we shall hope to have the pleasure of making her acquaintance.

"P.S.—I should like to add that since Christmas a great many people who attended your R.I. lectures have said to me how useful in many ways the lectures were to them. Some, I know, are following them up by home reading. I think it may be gratifying to you to know this.—M. L. H."

On January 28th, 1886, he received a letter from Benjamin Apthorp Gould, which is reminiscent of Sir William Rowan Hamilton:

"You very kindly say that you wish you could have been at the Vendôme Hotel. May I reciprocate in wishing I could revisit the Dunsink Observatory, where in the first week of September, 1845 (*eheu! fugaces*) I passed a most delightful day with that delightful man, Sir Wm. R. Hamilton. Through all these years the remembrance of his genial, cordial hospitality has remained vivid, and of how he walked in the bright evening back to the city with me, a boy of twenty—to make sure that the inexperienced Yankee should not lose his way."

Having become famous as a popular exponent of astronomy, my father received numerous letters from people who were wholly unknown to him, asking for advice and assistance. Before his correspondence grew too large he would generally reply to these letters. If asked for his autograph, he would generally send it on a post card—his theory being that, although such a favour was not worth asking, it was not worth refusing. Here is a request, however, which was *not* granted. Writing from Cardiff, a young man who shall be nameless said:

"I am a young and enthusiastic astronomer, but hitherto have been under the great disadvantage of possessing only a telescope of small aperture and very low magnifying power.

"I am therefore taking the liberty of writing to beg from you the favour of a subscription towards the purchase of a much larger instrument.

"This is a course which I have long hesitated to adopt, and I sincerely trust, sir, that you will not regard this in the light of an ordinary begging letter, as my salary is quite sufficient for my daily needs. But I have for a very long time set my heart upon a large telescope, and if you will kindly assist me to the attainment of this object, and will kindly acquiesce in this (what may appear to you strange) request, I shall be most deeply grateful. With many apologies, I have the honour to be," etc.

Some idea of his many activities during the life at Dunsink may be obtained from his letters. On March 6th, 1886, he wrote to Professor Minchin:

"If you are dead and buried, why can't you say so like a man, and not leave me to learn the fact inferentially from your silence? I was meditating an advance on Cooper's Hill the last time I was over, but was not able to manage it. Come over and see us while we still exist. How is the book getting on? I long to have a talk with you over things sundry. I have been troubled since I saw you with my eyes—or rather eye. It had been failing for years, and now is wholly gone. However, the other is all right, and I am quite comfortable, except that I have to wear dark spectacles occasionally, and I make slight parallactic mistakes incident to a one-eyed condition. The German edition of the 'Theory of Screws' is going through the press. I have seen the first forty-eight pages. It will be much larger than the original, as not only are all the papers added, but there are copious notes introduced by the editor. I am also seeing the 'Admiralty Manual of Scientific Inquiry' through the press, and correcting a new edition of the 'Story of the Heavens,' which has had a success that I did not expect. I am trying to get my notions on the Dynamics of Elliptic Space into shape, but it seems a tremendous subject, full of interest at every point and with countless theorems of the most ravishing beauty. I cannot tell you how much pleasure it gave me when I knew that you had read the 'Screws.' There is still a great problem to be solved which, after fifteen years, I feel as far from as ever. It is this. Given the impulsive screw, deduce by geometrical construction with the momental ellipsoid (?) the corresponding instantaneous screw. I could worship the man who could give an elegant Poinsot-like solution to this."

To those who consulted him upon scientific matters not connected with astronomy he would sometimes send a playful reply. The Rev. C. B. Phipps has favoured me with an account of a certain correspondence which his father had with Sir Robert. Writing to me on May 15th, 1913, he said:

"My father (now deceased), Charles Hare Phipps, M.A., T.C.D., was a regular correspondent, about thirty years ago, with Sir Robert, and I have many times seen and read Sir Robert's letters to him. One letter I am particularly anxious to find—it used to tickle me much. About thirty years ago my father invented a 'perfect' lifeboat, about which he consulted Harland and Wolff; but his invention did not meet with the attention it deserved (?). In desperation my father submitted all details of his marvel to Sir Robert, who wrote in most eulogistic terms of the lifeboat. Then followed a postscript, which I remember only too well: 'P.S.—The only thing, my dear Phipps, to be said against your invention is this—the lifeboat would not float.—R. B.'"

On January 11th, 1886, he received the following letter from Lord Carnarvon, who was then Lord-Lieutenant:

"The eminent services that you have rendered to science and education will, I hope, justify in your eyes the proposal that I am about to make. It would give me great pleasure to confer upon you the honour of knighthood—if, as I trust, this should be acceptable to you.

"May I add that, in proposing this public recognition of high services, I am making it not only to the Astronomer Royal, but to the Professor of Astronomy in the University of Dublin."

The ceremony was duly performed at Dublin Castle on January 23rd.

My father thus described the receipt of this letter to his sister, Mrs. Millington:

"I want to tell you a secret which I think you will be glad to hear.

"The Provost sent a special messenger here yesterday directing me to come in at once. When I did so he handed me a letter from the Lord-Lieutenant to the effect that he wished to do honour to me and to the College at one stroke, and that he had written a similar letter to Dr. Hart, and that we are both to be knighted forthwith!

"That I should be one of the two selected out of the University, and chosen, I have but little doubt, by the advice of the Provost, has gratified me and Lady Ball (!) to no little

extent. The letter was a very nice one, and the whole thing has arisen in the most gratifying way.

"I believe this is not to be mentioned until the Edict appears from the Castle, so, except to the Doctor, please do not mention it at present. To think of Dr. Hart and myself in the same boat!

"Of course, this association with the College makes it very flattering. I am gratified to believe that the College endorse the closing words of the Provost: 'It has been well earned.'"

From a large number of letters of congratulation which he received I select the following.

From Professor Piazzi Smyth:

"How admirably Lord Carnarvon has proved the general estimation in which he is held as the best Viceroy there has ever been in Ireland, by picking out for the high honour of knighthood the man of ablest mind, highest ideal, and noblest of pursuits in the kingdom, viz., the present Astronomer Royal thereof. With hearty congratulations to yourself I remain, etc."

Professor George J. Allman, from Ardmore, Parkstone, Dorset, wrote:

"To myself specially it brings a pleasure of no common kind when I reflect on the fact that he who has been deemed worthy of this royal distinction is the son of my dear old friend, with whose memory that of my student life and of my early work in a field in which both of us laboured side by side is indissolubly linked."

Professor John Casey wrote:

"Allow me first to congratulate you on your well-merited distinction. I must say you are in good company in having the Vice-Provost of Trinity College as sharing in the same distinction! I cannot tell you how glad I felt when I was told of it in the Irish Academy.

"I read your 'Story of the Heavens' with the greatest delight. Your power of popular exposition is wonderful!"

While he was at Dunsink my father read numerous papers at the Royal Irish Academy. The secretary has kindly favoured me with the following account of his connection with this institution:

"He became a member in January, 1870, and on March 16th following he was elected to the Council—a very unusual thing, as in most cases it is after years of membership that one is elected to the Council. He then became secretary of the

Academy in June, 1877, and held the office until 1880, but, with short intervals, when he retired in rotation, he remained on the Council until 1892, when he retired on account of his migration to Cambridge. He was a vice-president of the academy from 1885 to 1892.

"If he had not gone to Cambridge he would certainly have been elected to the presidency of the academy in 1896, the year in which the late Earl of Rosse, F.R.S., was elected. As the work of the academy includes archæology and linguistics, as well as science, it is the practice to alternate representatives of the two sides in the election of president. Accordingly, when Dr. Haughton retired from the chair in 1891, Bishop Reeves was elected, but as he only lived one year after his election, and as the presidency is for five years, Dr. Ingram was elected for the remaining four years of that term; and so the next science turn did not occur until 1896, when Sir Robert was already settled in Cambridge.

"All those who have been long enough connected with the academy to recall his presence amongst them retain, as you can well understand, the happiest recollections of his genial and kindly ways."

On December 8th, 1879, Sir Robert had been honoured by receiving from the Royal Irish Academy a Cunningham Medal for his "Researches on Mechanics." Mr. W. Archer, F.R.S., was at the same time presented with a similar medal for his "Biological Researches." The President, Sir Samuel Ferguson, LL.D., Q.C., spoke as follows when presenting the medal:

"Dr. Ball's title to an eminent position in the world of Irish science, and in this academy, might claim the sanction of hereditary right—a claim which those who, like myself, have had the pleasure and advantage of association with his esteemed father in those efforts for the promotion of scientific objects to which much of the present eminent position of this academy is due—would be the first to recognise; but he can afford to waive even such well-founded rights to our sympathy and respect, and to rest his claims to the well-deserved honour he is now about to receive, on his own individual services to science and to the academy.

"Having devoted himself specially to the cultivation of the mathematical and physical sciences, Dr. Ball became Pro-

fessor of Applied Mathematics in the Royal College of Science, on which position he conferred special value and importance by his admirable lectures on practical mechanics, and by the organisation of laboratories for physical research and instruction. Those lectures have been published, and constitute a work of standard value in scientific literature. Some other works on mechanics and astronomy, of a more elementary character, served to illustrate Dr. Ball's powers as a clear and popular, while thoroughly accurate, expounder of scientific truth, as did also the various papers read and explained by him before the members of the academy. It is not, however, for those more popular results of Dr. Ball's labours that the Council have on this occasion showed their sense of his merits as an original thinker and discoverer in science, but for work of a more recondite character, the nature of which is much less capable of popular description, but the value and importance of which has been abundantly vouched for by the suffrages of eminent mathematicians throughout Europe. I refer to the series of memoirs published partly in our 'Transactions' and partly in those of the Royal Society of London, and finally completed and published in a separate and independent form in his work on the 'Theory of Screws: A Study of the Dynamics of a Rigid Body.' . . .

"It would not, however, sufficiently indicate the services rendered to science by Dr. Ball were I to omit to state that, since the transfer of his labours from the Royal College of Science to the University Observatory at Dunsink, he has zealously devoted himself to those astronomical researches for which a remarkable combination of mathematical and mechanical ability has so highly qualified him. Already he has laid before this Academy several memoirs embodying valuable observatory work, and I understand that researches now in progress, especially as regards the important subject of parallax, promise to afford results which will redound to the credit of the University and of this Academy."

CHAPTER IX

LOWNDEAN PROFESSOR AT CAMBRIDGE: 1893–1913

MY father did not write any account of his experiences at Cambridge. I have therefore been compelled to construct this chapter very largely from his letters. If they do not tell a connected story, they will give some idea of his many and varied activities during this period.

On February 20th, 1892, Sir Robert Ball was appointed to fill the Chair of Lowndean Professor at Cambridge, in succession to Professor John Couch Adams. Shortly afterwards he was appointed Director of the Observatory, where he went to reside with his family in March, 1893. He held both posts and continued to live at the observatory until his death on November 25th, 1913.

He applied for the Cambridge professorship shortly after the death of Professor Adams. Writing to Mrs. Millington (February 15th, 1892), he said:

"I little thought when the doctor told me of the death of Adams that evening at your house, that it was likely to cause me so much deliberation. I have, however, applied for his professorship, and the matter will be decided on Saturday. There are so many pros, and so many cons, that though I am sure I have done right in applying for it, yet I hardly know whether to hope that the telegram to arrive on Saturday will contain 'Yes' or 'No.' Of course, the dear mother is a very important element. Among the cons, however, as I would have *seven* months quite free at Cambridge and not be exactly killed by work during the other *five*, I dare say we shall see nearly as much of our friends over here as we do now."

He wrote to his mother on hearing of his appointment as Lowndean Professor (February 20th, 1892):

"The die is cast and to Cambridge we go. I know no details, except that Sir W. Thomson and Professor Darwin (both of them electors) and also Professor Macalister telegraph congratulations. I am sure we have done the right thing, though,

as you may imagine, it is the sundering of our links here that at the moment I am most thinking of. But at my time of life to have only five months of duty instead of ten, and to have advantages of all kinds for the children that I cannot give them here, are reasons that we cannot get over. It was clearly my duty to try.

"Of course, my dearest mother, it is you of whom I am specially thinking, but I dare say I shall see quite as much of you as I have latterly been able to do. It will certainly be oftener than once in seven years (as Miss Garnett says) that I shall accept the comforts of your spare room.

"As yet, of course, nothing whatever is settled as to the when and how."

In lighter vein he wrote to his sister (February 20th):

"Yes, it is a great affair! I suppose it is perhaps the highest scientific chair in England, if not in Europe, the Solar System, the Milky Way, or the Universe!

"Truly a full week for our family. Poor Val off to Egypt, and 'Rob' to Cambridge!

"The telegram announcing the appointment came to-day, and was opened by Randal * in the presence of the household:

"'You are elected. Sir William Thomson joins in congratulations.'

'Tis seven months' holidays.
'Tis easier for the housekeeper.
'Tis better for the children.
'Tis no cows.
'Tis no horses.
'Tis a lovely garden.
'Tis nearer Amelia.
'Tis awful fame and honour. But, alas!
'Tis away from poor mother.

But I dare say I shall spend quite as many hours with her as I now do."

To Mrs. Adams (the widow of his predecessor) he wrote (February 24th, 1892):

"I can assure you that it is with a heavy sense of responsibility I find myself called to the chair that will be for ever famous as that adorned by him whose loss we so deeply deplore.

"It will not, however, be now for the first time that his example will be a stimulus to me. It was reading the account of the discovery of Neptune in the 'Orbs of Heaven' when I was a boy that first turned my attention in the direction of

* Captain Randal Gresley Ball, Royal Inniskilling Fusiliers.

astronomy, and well I remember the pride with which (in about 1864) I accompanied Professor Adams on a walk round Howth, when we paid a visit to the Baily Lighthouse. He has always been a hero to me; and when from time to time I have found opportunities of expressing my admiration of his noble work, I have never failed to do so. For example, I wrote the notice which appeared with his portrait among 'Scientific Worthies' in 'Nature' some years ago (Oct. 14th, 1886).

"I enclose a letter which he most kindly wrote to me in reply to one of mine asking for advice as to the line of work I should follow at Dunsink.

"It gratifies me very much to know that a memoir is to appear. Will you permit me to say that if in any manner whatever I can aid the work I shall esteem it a high honour and privilege to be allowed to do so?"

He wrote to his daughter Minnie (now Mrs. Barcroft) (March 5th, 1892):

"As to the professorship, it is a very mixed matter. I am, of course, quite sure that the change will be for *all* our benefits, but at the same time I am so sorry to break all our ties here. We had almost a touching scene at the Zoo this morning when they passed a resolution of regret at my departure, and indeed it is one of the things I regret most. However, I trust we shall be over a good deal from time to time.

"But the advantages of Cambridge are so many for all of us that I have no doubt whatever as to the move. It will be so much easier for the mother and so much more advantageous to all of us to have the abundant intellectual society. Then, too, we can get a good day school for Randal, and we shall be able to see our friends often."

From amongst the numerous letters of congratulation which he received I select one. It is from the late Sir David Gill (March 9th, 1892):

"I have just heard that you have been elected Adams's successor at Cambridge, and I write at once to congratulate you, or rather, to tell you how much I think Cambridge is to be congratulated. I did not think they would be able to tempt you from Dublin, and I wondered where a suitable man could be found. There is a noble transit circle and the makings of a grand equatorial, and I think it would have been a thousand pities if these had been put into the hands of a man who is *only* a mathematician. Besides all the possibilities which your equipment presents, there is a great mass of Adams's unfinished work which astronomy stands sorely in need of.

Lowndean Professor at Cambridge

"When Darwin was made Plumian Professor I urged him to take up the Theory of Jupiter's Satellites, and the construction of new tables. He began the work, and after labouring for some time went to Adams to discuss some of its points with him. Adams took him to a closet whence he produced papers showing that all Darwin had been working at for a year had already been done by himself, and indeed more, so, seeing that he was working on ground already occupied, Darwin went no further.

"If Darwin and you, in conjunction with W. G. Adams, would take up the editing of J. C. Adams's unpublished papers, you would confer a great boon on astronomers, and help also to erect a great memorial to your great predecessor. The fact of the existence of these papers has deterred many an able young man from entering a field of work in which he knew that Adams had been working before him.

"Forgive my presumption in making these suggestions. I only make them now because I know that very soon you must have completed your working programme, and, if my suggestion is of any value now it would then be too late because your hands would be otherwise full."

In July, 1892, my father was admitted to a Fellowship at King's College, Cambridge. A letter to his sister records this fact:

"I went over to King's College, Cambridge, last week, and was formally admitted a 'Fellow' of that august foundation. It is truly a grand place, and the reception given to us on all hands is the kindest possible. I stayed with the Provost. It strikes a Trinity College, Dublin, man as strange that Cambridge is governed by comparatively young men!

"Yes, we did indeed wish much for you. The celebration of the Tercentenary of Trinity College, Dublin, was a superb function in every way. The presentation of addresses was grand! As each continent or nation sent up its representatives a few bars of appropriate music, such as 'Yankee Doodle,' etc., stimulated the enthusiasm and the interest.

"I am to 'sit' to Miss Purser next month at her request. She is to present me to the College to be hung in the club room in a valhalla of a few worthies! What between this, and a message from Tennyson that he desires me to honour him with a visit, my head is turned!* Is it not pleasant to think we shall be within a few hours of each other? The more I see of Cambridge, the more delighted I am at the change for all our

* My father always regretted that he did not avail himself of this invitation, which only reached him indirectly.

sakes. We have finally decided to bring Willy with us and enter him at Cambridge next October. Then there is a capital school for Randal which belongs to King's College and is primarily for the choir, all of whom are picked boys."

On December 8th, 1892, the degree of Master of Arts (*honoris causâ*) was conferred upon him in the Senate House at Cambridge.

The following speech was delivered by the Public Orator, Dr. (now Sir John) Sandys, in presenting Sir Robert Ball for the degree:

"Nuper alterum ex Astronomiæ professoribus nostris Galilæi in Honorem ad Universitatem Patavinam legatum misimus.* Hodie alterum ex eisdem in Senatum nostrum honoris causa libenter cooptamus. Fato autem singulari, anno in eodem, et Galilæi gloriam et Academiæ Dublinensis famam ludis sæcularibus celebratam vidimus. Ergo hoc præsertim die, quo procul in Italia ludi illi, astronomi magni in memoriam indicti, sine dubio ad finem felicem perducuntur, adsciscere nobis consentaneum est Academiæ Dublinensis astronomum insignem, nuper nobis Neptuni inventoris celeberrimi† in loco professorem datum. Præceptorem igitur, non pueritiæ tantum, sed etiam juventutis et ætatis maturæ ingeniis feliciter erudiendis aptissimum, animo grato accipimus. Quod si præceptorum nostorum in ordine alii (ut videtur) Mercurii, alii Jovis sub sidere nati sunt, virum hunc certe, et eloquentia prompta et animo perquam geniali præditum, sidere sub utroque natum fuisse crediderim. Cæli vero inter sidera, præter Jovis satellites olim a Galilæo ipso primum observatos, nuper satelles quintus terris apparuit‡: in eodem autem anno (juvat recordari) inter tot lumina Academiæ, velut orbis quidam cælestis, Jovis satelles novus etiam nobis affulsit.

"Duco ad vos et Societatis Regiæ et Collegii Regalis socium, equitem insignem, Robertum Stawell Ball."

Upon arriving at Cambridge he was fired with the idea of installing a photographic telescope. Writing to Dr. Rambaut, he said:

"I am half inclined to go in for the photographic doublet. I see it could be housed in the fourteen-foot dome on the top of the house, or rather, I mean, in a new dome on the same wall. I don't think of giving the job to Becket, nor shall I invoke the

* Professor G. H. Darwin. † Professor J. C. Adams.
‡ September 9th, 1892.

aid of Mason Wyse!* At present the little dome is derelict with an utterly preposterous telescope of about two inches aperture on an English mounting that would carry a 100-ton gun, the whole being rusty and ruinous. The dome, however, runs well and goes with a push, but I think I shall try to get a new one."

Although he began his professional duties in the Michaelmas term, 1892, he did not go into residence at the Observatory until 1893. In a letter to his sister he wrote:

"To-morrow night we expect to sleep in our new home. A beautiful one it is in many respects. Indeed, as every day passes, I am more and more thankful for the change we have made. You can have no idea how charming is the prospect of life here. It seems to me that there are scores of hospitable houses open, and genial and pleasant welcomes everywhere. The people not *too* rich. Then we are to have a telephone. Vehicles of any kind at the door in a quarter of an hour, shopping and all the rest done by telephone! It is connected with the Post Office, so that telegrams can be sent all over the country and the world from our own hall. There is pleasant society in King's College. Indeed, I feel quite at home everywhere now. Small incidents of the change loom into importance. When I arrived, the two things I most appreciated were two pipes, not for tobacco, not pipes of port, but just a gas pipe and a water pipe, conveying the gas and the liquid of which we were so destitute at Dunsink!"

The quiet domestic life at Cambridge is fully and characteristically described to his mother in a letter dated April 23rd, 1893:

"I treated you to such a shabby scrawl last week that I must try to make up for it now.

"I do not see how I can give you a better idea of our life than by describing, say, this very day Sunday, how it was passed and what we have done.

"To begin with, it was a glorious morning, and into F.'s beautiful room the blessed sunlight streamed from the pretty window on the east which looks out on our lawn with a nice view to Cambridge. Another flood of light comes from the door leading to F.'s little boudoir, where the windows open to a balcony whence there is the same charming prospect of greenery and the distant Cambridge. Then there is another window in the room to the south with the *ampelopsis* clinging

* This individual used to effect occasional repairs at Dunsink. My father always said he was employed by the firm of "Botcher & Co."

around it. During these lovely days and nights the windows are open. We were actually awakened by the cuckoo the other day, and can hear the nightingales as we lie! The room itself looks nice. All the furniture has been repolished and our mahogany glows like new. . . . But the hour for getting up has come. In comes dapper little Bertha with the hot water, and presently I take my departure in my dressing-gown and slippers. Out along a long passage newly covered with oilcloth I go into the new house where, adjoining the bathroom (hot and cold all day and night) is my bright little dressing-room. There I find Randal in his bed reading a book, with 'Smut' wrapped up in a rug beside him. All my old furniture has been repaired and polished so that it looks capital, and while I am finishing my last touches, the gong rings to tell us that breakfast is on the table. Down I go either by the front stairs with its nice new carpet, or generally by the back stairs also with a new carpet. I forget, indeed, which I used this morning, but when I got down, there was the whole hall suffused with the glorious morning. I revel in the blessed sunlight. You will remember that at Dunsink our hall was rather dark. The hall looks so nice with the spick and span new floorcloth and two stands of flowers and ferns, and the pretty lamps, etc. Then into breakfast. Here the brightness was subdued by the outside blind, one of the possessions taken over from Mrs. Adams. The breakfast, and indeed all the meals, are managed in the English fashion which saves the housekeeper much trouble. Then after breakfast I go out for a few minutes into our beautiful shady walks, look at the towers of King's in the distance, and wonder what in the world I can have done to have deserved all the blessedness that has been poured on me! There is not in Cambridge, or in England, or in the world, I believe, so charming a position for a man of science! However, to my story. The time goes on and at ten off we start for chapel. We walked to-day. Had we elected to drive it was only necessary to go to the telephone and there to order what we want from a one-hoss-shay to a coach and six. But all are in good walking trim, so off we set, first for a few yards through our shrubberies sweet with flowers, and then down the long trim avenue to the Madingley Road. Then we turn to the left, passing a few fields, then the houses of a neighbour or two, and in a quarter of an hour we are at the 'Backs.' 'We' means F. and self, and the young people. Then along the Backs till we come to the lovely gate of Clare, up through the avenue of limes, just out to-day in their exquisite green, and then on to the bridge of Clare. Here we stop for a few minutes to enjoy one of the most exquisite views in England. In front palatial Clare. To the left along the River Cam we see Trinity and St. John's; to the right the

glories of King's; then over the bridge, everything looking its loveliest on this spring day, through the Halls of Clare, and then by a sharp turn to the right, through a wicket, we emerge under the shadow of King's chapel, one of the great glories of Christendom! Here we have still a quarter of an hour. I walk on ahead to put on my surplice and M.A. Cambridge hood, and then I join the party below and we enter the chapel. It is indeed a poem in stone. The lofty roof and the exquisite old stained glass windows through which the sun is streaming make it simply enchanting. I have my special stall in a most august place in the church. The service is intoned and choral, all nicely done, no sermon, so in little more than an hour we are out. Then, as it is the first Sunday in term, there are always kindly greetings and inquiries. We chat for a few minutes with the Vice-Provost and the Tutor and a few others, and then we go up to W.'s rooms to inspect them since their renovation. He has a glorious look out over the lawn to the river. We have handed over to him tables and various pictures and a chiffonier and other matters, so that now he looks really very smart, and then we walk towards home, R. having elected to stay behind with W. to come over a little later. I forgot to say that R. has a special seat in the chapel in connection with his school. We are back about one. Then I went for the next hour into F.'s little boudoir, where is an ample sofa for my behoof, and she and I read for an hour till lunch at two. W. had turned up by this time with George Loane, a nice fellow, indeed he is, and then after dinner the young people went their way on a ramble about the place. F. and I went ours; we looked through the gardens at the beautifully trained fruit trees covered with blossom, we looked at the great box trees and the big Wellingtonia, and the great monkey puzzle and many another interesting tree and plant. We went into the greenhouses, bright and fragrant, and then into the vinery where already there are clusters of miniature grapes. Then we walked round our shady walk, and had just come in when Major MacMahon and Mr. Larmor were announced. These are two great mathematicians both of whom I knew before. That led to a pleasant little gathering, and tea on the lawn. Presently they left, and then after another hour's reading I stole into my study, where I am now writing with a portable gas lamp, which is a great blessing. F. is opposite to me reading one of the volumes of the 'Encyclopædia Britannica.' I have just bought twenty-five volumes in Russian leather. It is now 9 P.M. R. has only just gone to bed, and the young people with Mr. Harmer are in the morning-room.

"F. began to pay off her scores of visits this week. She had an open carriage for three hours on Friday and polished off I

know not how many, as they were all out, and no wonder, this lovely weather. Yesterday she and I started off and we walked right to the other side of Cambridge and back again, and paid three visits to Sir George and Lady Stokes, Professor J. J. Thomson, and to two wonderful widow ladies, Mrs. Lewis and Mrs. Gibson, who have just returned from an expedition on camels to Mount Sinai, where they have been studying ancient manuscripts in a monastery! They have discovered a new manuscript of the Gospels. They delighted the monks by prattling to them in modern Greek. They can also talk Arabic, Syriac, Armenian, and I know not what other tongues.

"From all these various matters you will infer that we are getting along here, and so indeed we are. I feel I can say as Brinkley said, that I may

"Bless my *STARS*."

He wrote again on May 7th:

"Many thanks for your letter. I had such a pleasant account from L. Steele of his visit to you. We have now the pleasure of expecting Amelia on Monday week. She will see Cambridge at its best. It looks more lovely every day as the trees get brighter. We have torrents of visitors, three or four sets every day. To-day brought us Admiral McClintock and his daughter! They were staying at our Provost's, whose wife is a grandniece of Sir John Franklin, and she has kept up with the McClintocks ever since. He was much interested in a chat about old friends.

"Another visitor to-day was a friend of mine and a brother-fellow of King's, Professor Middleton. He received this morning the intelligence that he is to succeed Sir Cunliffe Owen as director of the South Kensington Museum. Val will be interested in this. He is an extremely nice man, greatly respected and loved here, and will be much missed when he moves to London. He has just married, and his wife will dignify the halls of South Kensington. Last night we dined at the Provost's to meet Admiral McClintock. To-day we met Mr. Leonard Courtney and Sir John Gorst. In fact we are in the full tide of life. Young and old seem to enjoy it thoroughly and realise the advantages by which we are surrounded."

And on May 13th he wrote:

"We have been going on here as well as possible. Who was the mendacious person who said that the English people were cold and stiff? They have, at all events, taken to us most kindly and warmly, and nothing could be pleasanter. I feel at home here already to an extent I never could have expected. As the Vice-Provost of King's said to me, 'You have taken to Cam-

bridge like a duck to water.' It suits me perfectly. The academic life is what I like and am fitted for. We have had certain dinner parties, and there are others in prospect. There is a wonderful charm in this abundance of intellectual and kindly society.

"Did you hear that I have been invited as an honoured guest to the dinner of the Society of Authors? All the great writers of the day in history or science or romance will be there, including such notabilities as Lord Kelvin. Is it not an honour even to be asked to be present, but what will you say when you hear that the chair is to be taken by Sir Robert Ball? Think of that! Such a recognition as that has indeed startled me. You cannot think what offers I have had to go on a lecturing tour round the world. I have been offered *a fortune*. Of course, it is out of the question to think of it at present. But if some time I could give up a year to it I might. I could then retire for the rest of my life. Perhaps I may later on.

"Another proposal has been made which I can and shall accept, as it suits my tastes perfectly. It is that I shall prepare for the Cambridge University Press a treatise on the advanced and difficult parts of mathematical astronomy. I have often wished to give my mathematics full scope but never could do so heretofore, for such a book would not pay. Now, however, as the University will pay for the book and assume the whole responsibility I shall write it with all my heart. It will be most useful in connection with my University lectures. There is nothing which has occurred for many a long day which has given me so much satisfaction.

"Last week I went to 'town' (that is what we call London here) for the *conversazione* at the Royal Society. There were troops of friends there, and many kindly greetings. Last week I wrote a letter to Sir Andrew Clark to tell him that *the year* had now elapsed since my visit to him. During this time I have not had one headache worth mentioning in comparison with the awful headaches I have suffered from for so many years. I cannot tell how indebted I am to his advice for this blessed change."

On May 28th he wrote to his mother:

"Still the visitors are pouring in, and the invitations too. We seem to have troops of acquaintances now. It is often not a little puzzling to know them separately. However, they make allowances for new-comers. I think we have lost all feeling of shyness and strangeness. Is it not curious that I should now be thrown up against my old friend or playmate, at all events, in Rutland Square in the days of my childhood—Jebb? I was asked the other night at a party whether I knew Sir Richard

Jebb. 'Yes,' I replied, 'I knew him before anyone at this table knew him.' He quite remembers our old acquaintance.

"But mentioning Jebb reminds me that I made my début in the political world on Tuesday. You will see about it in the paper which I send herewith. They wanted me to take a more prominent place than I did, but I could not undertake to prepare a speech when I had so much to do. The undergraduates were rather disturbed by some of the opposite party, so that I cannot say things went on smoothly. Then after the meeting was over there was a torchlight procession through the town and fireworks. They were going to burn Gladstone in effigy, and sent up to Whiteley's—who undertakes to provide everything—for the effigy, but he was for once unequal to the occasion. I also enclose you the 'Hymn to the Lowndean Professor.' It is very clever, but perhaps you are not fresh enough in your Euclid to take it in. Please send it back.

"You would be delighted to see the flowers in Cambridge! The window sills in glorious King's are all ablaze with geraniums, nasturtiums, and lobelia. Indeed, in the matter of flowers and greenery Cambridge is enchanting. Every house has its nice bit of bright garden, even in the middle of the town. There is hardly a spot, perhaps not one, from which trees cannot be seen and the lawns are delightful.

"But you *have* been going it in Dublin! It seems that the inhabitants have nothing to do but to get up tremendous bazaars and then spend oceans of money in them. Where does all the money come from in that distressful country?

"I have at this moment no fewer than three books on hand, not to mention all sorts of other work."

The following letter to his mother (November 19th, 1893) gives some idea of his busy life:

"We are getting on merrily here. Perhaps my diary for the next four weeks may assure you. Here it is:

Nov. 13. Lecture at London Institution.
14. Audit dinner at King's.
15. Lecture at Manchester.
16. Young people's dinner party of sixteen at home.
17. Dine with Benchers, Lincoln's Inn.
18. Dine with Public Orator, Cambridge.
19. Sunday—quiet at home.
20. Lecture at Bow.
21. Dine with Mr. Dale.
22. Lecture at Birkbeck Institute.
23. Dine at Caius College.
24. Lecture at Anerley.

Nov. 25. Dinner party of sixteen here.
26. Sunday—quiet at home.
27. Lecture at Tunbridge Wells.
28. Lecture in London.
29. Concert here (to which *I* must go).
30. Dine at Royal Society annual feast.
Dec. 1. Lecture at Wimbledon.
2. Concert here. (*I* am not going.)
3. Sunday—quiet at home.
4. Dinner party of sixteen here.
5. Actually nothing whatever!
6. Founders' dinner at King's.
7. Lecture at Barnsley.
8. Lecture at Wimbledon.
9. Dine with Mrs. Lewis. And
10. Sunday—quiet at home.

So there is four weeks for you! Even in Dublin I don't think you can beat that!"

Visitors to the Cambridge Observatory will have noticed a building on the left-hand side at the top of the avenue. This contains a curious telescope which was erected during my father's time. An interesting account of the preliminaries to the erection of this telescope is contained in a letter to Dr. Rambaut (January 4th, 1897):

"Common was down here the other day giving us another lift about our photographic telescope. Grubb has made some progress, and we have now got our designs for the building into shape. I can't say that I am by any means free from anxiety on the matter. Gill scouts the whole thing, but I have the greatest reliance on Common's mechanical skill, and he seems to have no doubt that the thing will succeed. Common told me that he is now prepared to make mirrors for any astronomers who want them, charging them merely cost prices. Did you know that his method of testing a flat mirror is a purely mechanical one? That is to say, having first prepared by infinite pains a single plate which will stand Lord Rayleigh's excellent test of covering it with a very thin plate of water he immerses it in a vessel and then tests the uniformity of the thin plate by colours. He employs this for reference. He uses a spherometer which will read to the three hundred thousandth of an inch, and adjusting this on his standard plate he is able to work up the plate to correspond to it. It used to be an article of Lord Rosse's faith that the ultimate figure of the mirror was too refined for any mechanical tests, but this, Common says, is

not the case. A mirror which possesses errors so large that the spherometer referred to will exhibit them conspicuously, may still be perfect for all practical purposes of astronomy."

These letters serve to show that he was prepared to like his new surroundings, and it may truly be said that his affection for the University, her colleges and her professors steadily increased during the twenty-two years he lived at the observatory. In the midst of his mathematics and his astronomy he found time to take an active part in the government of the University. He served on various syndicates, and was an *ex officio* member of several committees of selection for professorships. In 1902 he was elected to the Council of the Senate, and in 1906 he was re-elected for a further period of four years. He greatly appreciated this preferment, and was constant in attendance at meetings of the "Cabinet of the University."

Writing to his sister (December 15th, 1902), he said:

"Did I tell you that I have been put on the Council here, an august body which manages the whole University? The work is exceedingly interesting, lying as it does at the very heart of University matters. There is nothing of importance which does not come before us. I am appointed for four years, and whether they will put me on again at the end of that time, or whether I would care to go on again, remains to be seen. There are four representatives of the professors on the Council, and three of them are Irishmen!"

He was always immersed in affairs at Cambridge, and was frequently invited to present the prizes at various schools. On February 19th, 1900, he wrote to Mr. Steele:

"We have had all sorts of things going on here. The other night I was on the barrel beating the big patriotic drum for the Volunteers, to an undergraduate mass who yelled their sympathy and approval!

"To-night I am to distribute the prizes at a girls' school in the Guild Hall. I am to make a speech on goodness only knows what, but I understand that I must refer to Ruskin, the May Queen, the advantages of cookery lessons, female franchise, and the merits of higher grade schools for the daughters of college bedmakers! Then I am to give a lecture on behalf of 'District Nursing' as per enclosed! The theatre is expected to be filled, and phenomenal receipts are anticipated. This, too, in spite of the fact that the faith-healing party is prominent in Cam-

bridge. They now hold Sunday meetings to cry 'down with priests, doctors, and all other embodiments of superstition and vanity.'

"*P.S.*—I am bursting—just bursting (2,000 lbs. on the square inch) for a good talk!"

He frequently attended public dinners in London. Here is an account written to his mother of a dinner at Lincoln's Inn (November 19th, 1893):

"I was in such grand company on Friday! There was a great legal party at Lincoln's Inn and twelve guests, including Mr. Gladstone, the Prince of Wales, Mr. Balfour, the Prince of Siam, Sir Robert Ball, and a few others. It was delightful. Everyone was so kind. They all seemed to know me so well. I was received by Sir Charles Russell, while the Solicitor-General and Mr. Napier Higgins were told off to see to my particular welfare. I did *not* have the honour of a chat with H.R.H. nor with Mr. Gladstone. Benchers and their guests sat at the high table, 300 barristers were in the body of the hall, and the students were in the gallery. Nearly all say they are so glad W. is to enter there as a pupil. Two of the Benchers are to sign his papers, and two others of them have given me a general invitation always to stay at their houses when I go to London."

The following stories and extracts from letters received from my father during the Cambridge period have been contributed by a friend:

"We (Sir Robert and I) were taking a delightful walk through the Fen country. We arrived at a little inn which bears the sign, 'Five miles from Anywhere. No hurry,' exceptionally thirsty. We could get only half-bottles of soda-water. Apropos of nothing, I asked him if he had ever drawn up a 'homicidal list' of people he would shoot at sight. 'Yes, certainly,' was the reply; 'and I have headed my list with the inventor of half-bottles of soda-water!'

"We were talking of someone whose powers of digestion were exceptional. Sir Robert said: 'I wonder if he ever tried *padlocks?*'

"I went with him to a hairdresser's in Newry. The proprietor, a German, greeted him effusively as an old client with the words, 'I am ver' glad to see you, Mr. Johnson. It is long time I have seen you; I have seen you last in Belfast. It is ver' pleasant.' R. listened to this and many more remi-

niscences, and said that he too was glad to meet him. 'But,' he added, 'I think I ought to tell you I am not Mr. Johnson.'

"He told me of another visit to a barber, when he was informed that his hair was getting very thin, and the barber recommended the use of a certain lotion.

"Sir Robert: 'I bought a bottle of that lotion when I was here last——'

"Barber (interrupting): 'On looking closer, sir, I see signs of improvement. The new hair is beginning to appear.'

"Sir Robert: 'But I never used it!'

"He once met a lady in the carriage of a Swiss mountain railway who was extremely nervous about the ascent. By way of comforting her, he said: 'Well, madam, there are four things which must give way before we are hurled to destruction, and so far only three have been known to fail. When the fourth goes, you won't have time to say your prayers!'

"Talking of a certain professor whose energies as a college tutor were not remarkable, he said: 'I believe he finds it almost impossible to do any work *between meals.*'

"He spoke of another professor who was deplorably ignorant of any subject outside his own. Going one day to a college library, he said to the clerk: 'Would you direct me to some book which would explain to me clearly the difference between longitude and latitude, as there seems to me to be an unnecessary amount of complication about the matter!'

"He once told me of a scientific meeting where the question arose as to why the woodcock, which starts in a bee line south in its migration from Norway, should arrive on the west, and not on the east, coast of Ireland. The explanation suggested by a learned geologist present was that the diurnal revolution of the earth during the bird's passage had brought the west coast under it by the time it had reached Ireland!

"He spoke of one of his cousins, who, in his youth, was fond of the wildest pranks and adventures, but was nevertheless of a religious turn of mind. When discussing his future career, this boy told his parents that the job he felt best qualified to fill was that of chaplain on board a pirate!

"Sir Robert also told me of an old friend of his who was always sceptical about the reputed wealth of the Irish heiress.

'In fact,' said Sir Robert, 'he had invented a formula for reducing an Irish marriage portion to its proper dimensions. It was: 'Take a nought off and divide by two.'

"With reference to the comparative smallness of the population of the earth in relation to its vast area, he said: 'The whole population of the earth might have comfortable seating accommodation in the Isle of Wight.'

"We were talking of the duration of the coal supply. He said: 'People say that when the coalfields are exhausted we can use electricity, forgetting that its production depends upon the coal supply. You might as well say that if the horse that draws the canal boat drops dead, we could still pull it along with the rope!'

"On one occasion he took part in a discussion on mathematics in its relation to statistics. Amongst other things considered was the number of barrels of beer of a well-known brand consumed annually. He mentioned that on one occasion all calculations proved erroneous. In no way could the brewer explain the increase in consumption during a particular month, until at last it was pointed out to him that the birthday of a famous temperance reformer fell during the period in question!

"I once asked permission to give his name as a reference when I was endeavouring to make certain lecture engagements for myself. Sir Robert wrote in reply:

"'You can, of course, refer to me when you are writing, and if they apply to me you will get such a character for a lecturer, that even though you were directly inspired at the supreme moment by the angel Gabriel, you would create bitter disappointment, such would be the expectations that will be raised by what it will be my duty to mention!'

"In reference to a lecture which I had given he wrote:

"'I knew your lecture would be a success; the very fact that you were anxious about it was to me an augury that it would be so. I often think of a remark I once heard David Plunket make, to the effect that all his greatest and most successful oratorical efforts had been preceded by many hours of the most dismal anxiety and painful forebodings of failure. Once you reach the callous state of a certain old veteran in the lecturing line, of whom you have possibly heard, the nervousness and anxiety are things unknown; but it is very doubtful how far this is

altogether an unmixed blessing so far as the audience are concerned, however greatly it may contribute to the lecturer's peace of mind.'

"With reference to the appointment of a certain man to a professorship, on the ground that he had 'teaching experience,' which his rival had not, he wrote:

"'Perhaps your friend has had teaching experience. This is the argument dear to the official mind, and conclusive. Just forty-five years ago they refused to give me a professorship at Cork, because I had no 'experience' of lecturing. May the Lord forgive them!'

"With reference to Boswell's 'Life of Johnson' he wrote:

"'I never till the present time read Boswell's Johnson. It is one of the greatest literary pleasures I have ever had; but I never find out these things till a million years after everyone else.'

"As to the appointment of Professor Whittaker as Astronomer Royal of Ireland he wrote:

"'Now let me commend to your most special and careful consideration my very great friend Whittaker. He is the only man I know of who can properly succeed Joly. And the place will suit him in every way. He is a keen gardener and a man who has infinite capacity for making things go. Then as to his scientific attainments, he knows more of the mathematical part of astronomy than anyone else in Great Britain, or if you like to add Europe, Asia, Africa and America, I won't demur. A modest, charming man in every way. He has already made one discovery which the greatest mathematician of the last two centuries would be proud to have placed to his credit.'*

"From a letter inviting me to join him in London:

"'But perhaps you will have to remain at home to learn Irish! I hear it is proposed that all the lectures in the National University are to be given in Irish, and that the *Pons Asinorum* must, in future, be demonstrated only with Book of Kells' capitals on the figures!'

"In praise of the Royal Dublin Society (written from Cambridge):

"'Perhaps since my residence at a distance I see the R.D.S. in a more just perspective than was possible when I was daily passing through it. I was always attached to it, but now I see

* See p. 164, *post*.

it as a society unique in the kingdom, steadily pursuing on the very largest scale a policy of the greatest beneficence and utility. Long may it flourish.'"

He was asked by Mr. Willett to express an opinion on the Daylight Saving scheme. He used to say with reference to this proposal that the astronomer ought obviously to oppose any scheme which would necessarily shorten his hours of research! However, he did write the following paragraph, to which prominence was given in one of Mr. Willett's published pamphlets:

"Which is the better for our waking hours, glorious sunshine, which costs us nothing, or expensive and incomparably less efficient artificial light? Only perverted habits could make us hesitate as to the answer to this question. The admirable scheme of Mr. Willett will rescue 210 hours of our waking life from the gloom of man's puny efforts at illumination, and substitute for it—sunbeams. There are no difficulties connected with the scheme which could weigh for a moment against the advantages of its adoption. Meridians were made for man, not man for meridians."

Sir Joseph Larmor has written as follows concerning my father's work at Cambridge:

"In 1892, Ball migrated to Cambridge to become Lowndean Professor of Astronomy and Geometry, in succession to the great dynamical astronomer John Couch Adams. Though his appointment cannot be said to have been anticipated by mathematicians at Cambridge, who were hardly aware that he was available for the office, Ball's reputation had preceded him. In those days, under the influence of Thomson and Tait, Stokes, Clerk Maxwell, and other mathematical physicists, mathematical studies at the English University were still cast in an objective mould. Instead of forming an isolated abstract discipline, mathematics was regarded as the key to exact knowledge in all those branches of science which admit of quantitative treatment, and it received a rich reward from them in turn by way of reaction. Applied mathematics was studied mainly in its relation to Natural Philosophy, to use a British designation which has persisted since Newton's treatise 'Philosophiæ Naturalis Principia Mathematica.' It had been recognised that mathematics had no great chance of popularity if its development did not interact with some of the objective natural

sciences such as astronomy, optics, or electromagnetics. As a result of this tendency, the 'Theory of Screws' had already become known at Cambridge, and especially welcome from the feature that the arguments were clothed in a charming combination of geometry and dynamics. Long after he came to Cambridge, when his activities were thought to be fully occupied in other directions, the subject continued to occupy his attention; and his friends received at intervals substantial quarto papers excerpted from the Transactions of the Royal Irish Academy, with the title 'Tenth' or other 'Memoir on the Theory of Screws.'

"His predecessor at Dunsink, Sir W. R. Hamilton, in his later years, had become, in a sense, obsessed by his own fundamental invention of Quaternions, and had spent much time in translating all known mathematics into the forms of that calculus, incorporating fresh discoveries which suggested themselves as he went along. It was even said that he would sometimes begin his Statutory lectures on astronomy in Trinity College, Dublin, by announcing that, in order to have a proper conception of the beauties of mathematical astronomy, a just apprehension of the Calculus of Quaternions was essential, and after this the subject of astronomy might be no more heard of. In a lesser degree it may perhaps be said to have become fundamental in Ball's mind (though of late not insisted upon in public with the enthusiasm of earlier years) that the general spacial relations of dynamical science required for their adequate expression the imagery of the 'Theory of Screws.' He often announced courses of lectures on the subject; and his work on it was brought to an appropriate end by a monumental treatise (544 pp. royal 8vo) published by the University Press. In contrast with the earlier book, which every mathematician could find time to appreciate, this later volume is in the main for the specialist.

"In the early days of the 'Theory of Screws' Ball had made the acquaintance of W. K. Clifford at meetings of the British Association. They were drawn together by a common interest in geometrical forms, including non-Euclidean geometry; and both had a play of humour and frolic which made them for some years main upholders of the lighter side of the activities of that scientific body. About the same time he had inoculated his friend Professor J. D. Everett with

the ' Geometry of Screws,' to the great advantage of that study. I can remember an oracular announcement which he made to Everett to the effect that ' The Theory of Screws is now all done with; it is quite obsolete; it is all going over into non-Euclidean space.' I also remember him recounting, in more serious vein, how, at a meeting of the British Association in the 'seventies, there turned up a young geometer from the University of Erlangen, Felix Klein, already a leader in the German mathematical world. Klein told them about Plücker's linear complex, and certain recent developments in the fascinating field of geometrical relations which it involved, a field in which Klein had first shown his own genius. Ball described how he and Clifford captured Klein after the meeting, and sat up half the night exchanging ideas, the interview culminating with the impatient and admiring complaint that there was positively nothing they could tell him that Klein did not seem to know about already.

"I recollect an opinion expressed by the late Professor George Chrystal, of Edinburgh, who had every right to be heard on such matters, in the sense that, whatever might be the facts as to priorities, there could be no question but that Ball's contributions to the ' theory of Screws ' were tarred with the brush of genius.

"As to the relation of Ball's work to that of the more abstract geometers, reference may be made to the remarks of a high authority, Mr. G. T. Bennett, in an obituary notice published in the ' Proceedings of the Royal Society.'

"Ball's advanced lectures at Cambridge were not limited to geometry. He liked to expound at first hand the great French mathematical astronomers such as Laplace and Lagrange. In so doing he followed a tradition long observed at Dublin University, which was perhaps the reason of much of the success of the Irish mathematical school.

"A treatise on Spherical Astronomy was the last of his mathematical works. When the book appeared, in 1908, some of his friends were struck with wonder that the writer, whose sparkling touch pervaded his fascinating books on descriptive astronomy, and whose severer geometrical fancy ran through the ' Screws,' should have produced such a blunt, business-like book, almost forbidding in its strict attention to the often tedious routines of astronomical reductions—a book

which rivalled in dryness the most unemotional treatises of its class.

"When Ball emerged from his abstract labours—studies which apparently came very easy to him—he took delight in assisting generally to 'make things go.' Thus he was for some time chairman of the Conservative organisation in the University; but he refused to be beguiled into Parliamentary service. In a conversation with him on the need for an edition of 'Select Papers of Sir W. R. Hamilton,' at about the time when a concatenation of uncontrollable circumstances had landed me in the political arena, I remember his gentle rebuke that he would much rather see me prepare such an edition than become involved in the distractions of Parliament!

"A full and brilliant life was destined to end in a long and helpless illness. But the interests that were so vivid remained to the end, and when he could no longer take any part in conversation, it was an obvious pleasure to him to hear about what was going on in the University in which he had played a prominent and genial part, and in the larger scientific and social world without."

The rest of this chapter consists, in the main, of letters written or received during the Cambridge period.

In January, 1894, he had two unusual visitors at the Observatory. It appears that Mr. (now Sir George) Alexander was about to produce *The Masqueraders,* by Henry Arthur Jones, at the St. James's Theatre. The cast included an astronomer, and part of the scene was laid at an observatory.

Writing to Mrs. Millington, he said:

"You would be amused to hear who were here to lunch to-day, and still more to know the object of their visit! Mr. Jones, the playwright, and Mr. George Alexander, the actor, want to see the inside of an observatory, for they are going to represent it in the scene of a new play to be called, 'The Masqueraders.' Did you hear of the great fame John Todhunter has obtained from his play, 'The Black Cat'?"

His love for Christmas is shown in a letter to his sister, Mrs. Millington (December 26th, 1896):

"I am still fond of dear old Christmas! I listen for the joy bells, and even I was touched by the music in King's. The

choir is certainly lovely. We had unfortunately only a small party at the Christmas table, for Minnie was in bed with a cold, but, by timely measures, she seems all right this evening. We have a young American here. Like most of his countrymen he is much better read than the analogous youth of our country, and, moreover, he is not a bit shy, so that he is a very pleasant addition. . . ."

He was intimately acquainted with Professor Charles Jasper Joly, F.R.S., Astronomer Royal of Ireland, and with John Joly, F.R.S., Professor of Geology in the University of Dublin.

Of Professor Charles Joly, who died early in 1906, he wrote to Mrs. Millington on January 6th, 1906:

"Joly was my intimate correspondent for ten years or so, and I have a wonderful series of his letters almost all complete (over 100). They mostly relate to mathematics. It is a grievous blow to me. I prized his friendship and warm intellectual sympathy more than I can express, and I often thought (selfishly, perhaps) that as he was twenty-four years my junior, I might look forward to enjoying our friendly intercourse during the rest of my life. As is so often the case, I am now regretting many lost opportunities.

"I have derived so much benefit in every way from his knowledge and sympathy. We were engaged, in a way, almost alone among English mathematicians, in the pursuit of Quaternions and the Theory of Screws, and for many months back I had been most diligently studying his writings so as to bring myself up to the point where our correspondence and interchange of views might be still more fruitful. We had as our special object to make the wonderful life work of Sir William Hamilton better known, and now alas! . . . ."

He wrote to Mrs. Joly on January 23rd, 1906:

"It was always such a pleasure to us to think of you at Dunsink in the place we loved so much, and I cannot tell you what a happiness and interest and enjoyment to me his [Mr. Joly's] delightful letters have been for the last ten years. I have always preserved them carefully, and now treasure them more highly than ever. They began about scientific matters, and though science was always present, I have in the later letters abundant illustrations of his richly stored mind. What wonderful ability he had! The greatest difficulties to most of us seemed always easy to him. I had been so looking forward to the renewal of our letters, and now, alas! The greatest heights he would have reached easily if it had not been that he

was cut off so early. His splendid devotion to the memory of Hamilton will bear excellent fruit for countless years to come.

"Trinity College can ill afford to lose her most illustrious son.

"I am only anxious to know in what way I can, now or at any future time, be of any service to you or yours."

I have found a great many of the hundred letters referred to in the letter to Mrs. Millington. Most of them relate to higher mathematics, and are too abstruse for these pages. I have, however, selected a few which show that the minds of the two astronomers were ever running on the same great themes.

In a letter to Professor Joly, dated January 9th, 1900, he wrote:

"I am so glad to hear you say that you refer to the extraordinary accuracy of Hamilton's work and the unsparing pains he took. By the way, is there not some story or other to the effect that he walked one night the whole way from Dunsink to the printing office in Dublin in order to get a semi-colon changed into a colon? This will at least serve to illustrate the unsparing pains which you refer to. I greatly admire also your reserve in what you say as to modern developments, and as to the extreme caution needful in modifying or improving the Calculus. I am inclined to think you are very wise in not printing a bibliography. There are always such a lot of rubbishy papers and futile discussions which, though they may not be actual paradox, are still unworthy of being admitted, and yet, as you say, a hornet's nest is aroused. The quoting and reference now so extensively practised seems to be the bane of all literature. We are always told the Bible is the highest type of literary performance, and among its other excellences we don't find Joshua quoting Moses, or St. Paul expressing his acknowledgments to St. Luke. I don't doubt that Laplace's plan of ignoring everybody was the proper course for a Laplace. You will, I am sure, let me know when you are here, for both my wife and I hope to see Mrs. Joly this time."

On October 15th, 1900, he wrote to Professor Joly:

"I feel almost like the people who swore they would neither eat nor drink till they killed Paul; my object, however, not being the murder of an apostle, but the discovery of what is the real inwardness of the co-reciprocal screw system. Like you, I long to see such a system, and I know the sight would be worth seeing, but there are difficulties that for the life of me I cannot conquer at present, but I am sticking into it morning, noon and

night, and have certainly struck into some pretty and pleasant by-paths though I have not yet hit the main high road."

He also discussed educational questions with Professor Joly. On January 2nd, 1903, he wrote from Cambridge:

"The forces over here are marshalling on both sides for the contemplated attack on Classics as a compulsory subject. The Syndicate has been appointed (but not without a struggle) to consider the subject and report in the May term. I find it very hard to make up my mind on the matter. However, fortunately, I have not yet any occasion for doing so, but the report of the Syndicate will come before the Council in the first instance, and then we shall be in for a jolly fight. The Senate will probably not accept any change, for many will vote *non placet* because they think the proposal goes too far (whatever it may be), while still more will vote *non placet* because they think it does not go far enough. This place has the most perfect democratic government I have ever heard of. The youngest man in the place, if he has a little resolution united to ability, carries as much weight, and often more, than the most hoary-headed sage of three score and ten.

"I am so glad to hear the Quaternions are under way in the printers' hands. More power! I have banished all Screw temptations at present and am squaring up to my book on spherical astronomy!"

The references in this letter to "compulsory classics" are interesting. It is clear that in 1903 he had not made up his mind.

I am in a position to state, however, that, notwithstanding his early dislike for Greek and Latin, my father never voted for their abolition from the Cambridge curriculum. His view, often expressed verbally to me, was: "I should be glad to support the abolition of compulsory classics if I were satisfied that subjects of equal educational value could be found."

His love for mathematics and intense enthusiasm for the works of the great men Lagrange and Laplace often caused him to write delightful letters to those who were able to share his interest. From one of many letters to his son Robert on this and kindred subjects the following may be quoted:

"My lectures on the Planetary theory are in full swing now, and it takes me all my time and brains (and would take more of the latter, if I had them) to do justice to this subject, which is in truth one of the most magnificent intellectual achievements ever made by man. It is impossible to describe the beauty of

Lagrange's immortal theorems. (*Here follow several pages of mathematics.*) If Jupiter were simply reversed in his track, but every other circumstance of the orbit was left unchanged, all the guarantees for the permanence of the solar system would be gone! This is just one of the points established by beautiful mathematical reasoning."

Upon the discovery of radium the Lowndean Professor immediately began to consider the place which this new element occupied in the universe. On October 18th, 1903, he wrote to Professor Joly:

"Have you seen radium? It certainly gets over the greatest of scientific difficulties, viz. the question of sun-heat. The sun's heat cannot have lasted over 20,000,000 of years if it is due to contraction. But the geologists would have, say, 200,000,000. Now the discrepancy vanishes if the sun consists in any considerable part of radium, or something that possesses the like properties. It is a most instructive discovery. I feel it a relief, in the same way as I have often done when some apparent contradiction in mathematics has been happily elucidated. It seems now that the moon must have been appreciably nearer within geological times, and that the huge tides must have been responsible for the early stratification of rocks."

In May, 1899, the Cambridge University Press undertook the publication of "A Treatise on the Theory of Screws." This appeared in due course. Let me quote from a letter written to my father by Dr. Johnstone Stoney (May 7th, 1900):

"I warmly congratulate you on having got through the labour involved in your publication in full of your great work on Screws. It is truly a *magnum opus*, and the fundamental conception which you have followed up with such success strikes the mind as one of the most elegant in the whole range of geometry —or rather of kinematics. I shall value much, and on more than one ground, the copy which you have sent me."

In the same year he had some correspondence with his old friend Mr. Monck about the appearance of meteorites. He wrote to Mr. Monck as follows on April 2nd:

"Your book just reached me as I was leaving home for a trip to Ireland. I did not like to send merely a formal acknowledgment, so until I had read the book, as I have now done, I postponed writing.

"My first feeling is one of gratitude to you for the fresh light you have thrown on the subject by your vigorous and in-

Photograph by Stearn & Sons, Cambridge

THE MERIDIAN CIRCLE AT CAMBRIDGE OBSERVATORY

dependent treatment. So many of the people who write get into conventional habits of what it would be absurd to describe as thought, that it is truly delightful to read the views of a very able man who sets down fearlessly what he has to say. There are many points which I should like to discuss with you. At present I will only say that I thank you heartily for your kind word about the meteorites.

"The fact is that the common notion among astronomers, who have neither logic nor imagination, as to the origin of meteorites is the following beautiful syllogism:

"Periodic meteor showers enter the atmosphere from outside.

"Meteorites enter the atmosphere from outside. Therefore meteorites and periodic meteor showers have a similar origin!

"There is really nothing but this rubbish in support of what most writers take for granted, that the meteorites which are in our museums and the objects which make the Leonids are of a kindred cosmical character.

"The fact, however, that the Ovifak iron, 'meteoric' in its appearance, never left the earth at all (as is proved by the specimens at South Kensington) shows that the most characteristic 'meteoric' product is a terrestrial material. Peary's so-called 'meteorite' is, I believe, of the same character; while at Coon Butte, in Mexico, a pudding-headed geological survey man descanted on the miraculous coincidence by which a flight of great iron meteorites from heaven were dumped down into a bed of lava while that was still soft, so that the lumps of iron stuck out when the lava was cold. Of course, this iron, though certainly the iron nickel alloy, had come out from the earth with the basalt, but had never been shot away. Because it was the same stuff as is found in meteorites, thereupon, argues this sage, it must be a meteorite.

"A meteorite, like Macduff, was ripped 'from its mother's womb' from some great mass, certainly not from anything of the nature of a comet, while the periodic shooting stars are, of course, connected with comets.

"Other noodles have urged the resistance of the air as a difficulty when opposing the motion of a volcanic projectile at six miles a second. They fail to see that such an outbreak means a tremendous discharge of vapour, and gases as well, in the middle of which clouds of missiles may ascend without any atmospheric resistance. This was seen at Krakatoa."

After his work on "Spherical Astronomy" was published he wrote to Dr. Rambaut:

"I have seen no notice of my book except one in the *Scotsman*, and I have only had one letter on the subject which calls

for any remark. It was from Professor Newcomb, who, as you know, has recently published a book on the same subject. He wrote:

"'It is very interesting to notice how completely the purpose of your work differs from that of mine. You treat the subject as an interesting branch of applied mathematics, while I have mostly in view the requirements of the working astronomer.'

"This extract will be a useful pellet, when I am accused, as of course I may be, of having stolen everything in the book from Newcomb's work. Had I not this I should merely have had to fall back on the stupid fact that ninety-nine per cent. of my book was written before Newcomb's appeared! This being merely a truth would, of course, be no use in connection with the average 'review.'"

My father received many letters from readers of his books. Perhaps "The Story of the Heavens" was the one most frequently referred to. On November 25th, 1893, a lady wrote from Manchester:

"I feel that I must write and thank you for having written that glorious book 'The Story of the Heavens.' I have just finished reading it aloud to my husband, who has been confined to his bed for several months. It has given him the greatest imaginable pleasure. We have both enjoyed it most thoroughly and feel grateful to you for the pleasure it has given us."

The father of a midshipman wrote in January, 1894, to say that before his son joined the Training Squadron (H.M.S. *Active*) on a cruise to the West Indies he had given him a copy of "The Story of the Heavens":

"Whenever my son writes he speaks of the delight that it gives him, and he has also given us strange accounts of the ignorance of some of his messmates as to astronomical subjects. In a letter received to-day, writing from near Sierra Leone on Dec. 16th, he says: 'I have started a regular astronomical fever in the ship. Everyone is reading my book and hunting out the stars. All the principal stars in sight about eight to ten in the evening are well known to us, and as we go south there are still more new ones to be seen. The Commodore has given an order that an observation of a star is to be taken every night by the midshipman of the watch.'

"I am not at all surprised, having read some of your most brilliant and interesting writings, to find that your fascinating descriptions of the heavens have had this effect upon my boy and his shipmates. Last night I myself sat up until midnight reading 'The Story of the Sun,' and your other work lately

published. I thank you, therefore, on my own account for the delight you have caused me, and still more that your work is offering to my boy such an ennobling and stimulating study as that of astronomy.

"This, no doubt, is only one of many such tributes that you receive. But it is very sincere."

In 1897 there was a call for another edition of "The Story of the Heavens." The assistance of Dr. Dreyer was invoked on this occasion. On July 19th my father wrote, in reply to a suggestion that the chapter on "The Planet of Romance" should be expunged:

"I am not at all disposed to sacrifice the chapter on 'The Planet of Romance.' I quite agree in what you say, and that the evidence hitherto (Watson alone excepted) is entirely negative. But no amount of negative evidence will demonstrate to me that such a thing does not exist. *Primâ facie*, I think it very likely that intra-Mercurial planets do exist, and I can by no means treat as wholly unworthy of credence the observations of so skilful a man as Watson. But I have no objection to have the conclusion qualified a good deal, by saying that no such bodies have been seen by any of the modern investigators. I would like, of course, to have full justice done to Lockyer's work throughout. The meteoritic hypothesis will be a difficulty. We must, however, say something about it. I do not, however, in the least withdraw anything I have said myself with regard to the origin of meteorites. Everything that has happened since seems to make the terrestrial volcanic view of their origin a more reasonable one."

He had numerous letters from Professor Barnard. The following from the observatory of the University of Chicago (August 1st, 1901) is typical:

"I want to thank you for a copy of your most excellent little book on astronomy. I shall be glad to recommend it to those who want a most admirable and clear account of astronomy. Your writings are always so clear and satisfactory and are so easily understood by those who are not able to grasp the average writings on the subject. It is a pity there is not more written in this simple, clear, and comprehensible style.

"I also want to thank you for the copy of the paper containing the excellent drawing showing you lecturing in London. I wish I could have been at one of those lectures!

"Ah, me! I have just got back from Sumatra, where I tried to photograph the eclipse of May 18th. It makes me sick to

think of the whole thing, all that long journey, all the hard labour and anxiety, and all the most perfect preparations, everything to be lost by a few miserable clouds. It is too bad. I had made most admirable preparations; using the sixty-one and a half feet cœlostat with one plate *forty inches square* and two *thirty inches square*, and five, fourteen by seventeen.

"Everything was in splendid shape and worked to perfection and such a duration of totality! All to be spoiled by clouds. We passed close to Krakatoa in the Strait of Sunda. It was the most interesting thing we saw all the journey—mainly from the fact that it was the object that filled the earth's atmosphere full of dust for several years and caused our red sunsets of 1883, etc. I succeeded in getting some photographs of it. What remains is now 2,600 feet high.

"I left here on Feb. 6th for Sumatra and got back a week ago. It was a long journey—and the latter part of the return a most tiresome one. But if I had got a lot of fine photographs of the corona, I suppose it would have been different and that I should have sung all the way back. Verily the path of the successful is strewn with roses, and he that meets with failure finds nothing but stones in his way."

My father's joy knew no bounds when Professor Whittaker solved Laplace's Equation. He wrote to Dr. Rambaut (September 30th, 1902):

"Had Tisserand contained a solution of Laplace's Equation it would at once have become one of the great classics, but this discovery has been reserved for Whittaker. No mathematical discovery made within my recollection has given me the thrill that this has done! Every mathematician from the days of Laplace down would have been only too proud to have accomplished such a feat. The great beauty of it is that it is so simple. In these days when such awful mathematics are the rage a result so comparatively elementary (though it does involve a definite integral) is very refreshing."

A letter to his old college friend, Mr. W. H. S. Monck, dated March 31st, 1902, relates to the appearance of a new star. It had been suggested that the new heavenly body was the result of a collision between two such bodies in the sky, each travelling at immense speed. He had also been asked as to the relative age of the planets:

"It is indeed hard to understand the 18,000 miles a second of speed, and we must only await further information. The suddenness of the phenomenon seems to require something of the

nature of a collision, though indeed, if we had not seen such a velocity produced, I do not think we should have thought it possible. I cannot think that the view which supposes what we have seen on the photograph to be merely reflected light is tenable. Reflected light from such distances seems impossible, unless the photographic plate were capable of representing light a millionth part of the intensity of visible light.

"As to the relative ages of the planets I know nothing. I see in the spiral nebulæ the inner parts are sometimes more developed than the outer parts, and sometimes vice versa, and therefore the relative ages of the planets in our system is to me a phrase totally devoid of any meaning or physical significance. I only say to the other planets what the Irish carman said to the old lady, 'Whatever your age is, ma'm, you don't look it!'

"Your countenance smiles down upon me at one end of the group of ten which was taken some forty years ago. The other corner man, John Shortt, I had the great pleasure of seeing here the other day; he is, as you doubtless know, County Court Judge in Cambridge.

"I note what you say about the eclipses, and I shall preserve your letter, but I don't know anything about it at present."

His chief assistant, Mr. Andrew Graham, wrote the following interesting letter with regard to the discovery of Neptune:

"You recall to my recollection an incident, connected with the search for Neptune, which I related to you several years since; and which I had from the lips of the Rev. William Kingsley himself, one of the agents in the affair. You wish me to put it on paper, and I do so all the more freely as it is now of historical interest and ought not to be forgotten.

"About the time of the discovery, Professor Challis and the Rev. William Kingsley were dining in company at the Fellows' Table in Trinity College, when the conversation naturally turned on young Adams, of St. John's College, the brilliant Senior Wrangler, his researches on the perturbations of Uranus, and his attempt to locate the cause of those perturbations, which the attractions of Saturn and Jupiter failed fully to account for.

"Professor Challis stated that Adams believed that the irregularities were due to the action of a superior planet, about twice the distance of Uranus from the sun, and had actually given him the Right Ascension and the Declination of the disturber, obtained from his investigations; and, moreover, that he and his assistants had been examining places of unknown stars, and inserting them in an atlas for future examination. He added that a night or two previously he had detected in one of the stars what appeared to him a very small disc, which, of course, he

intended to re-examine on the first clear night. 'It is clear now,' said Mr. Kingsley, 'why not go to the Observatory and have a look at it?' They went, as soon as they could with propriety leave the hall, and began to prepare for going out to the Northumberland Dome, when Mrs. Challis interposed and said, 'You must not go out till you have a cup of tea.' They yielded, the tea was made and disposed of, they got on their wraps, and, alas, the sky was hopelessly clouded!

"*P.S.*—Airy heard it, but didn't believe it,
Challis saw it, but didn't perceive it."

In December, 1902, Mr. Samuel Roberts, M.P., wrote to Sir Robert with reference to certain pictures of the Great Comet of 1811. He said:

"I have referred to my grandfather's pictures of the comet, and I find it was 1811.

"1st Picture. As seen at Park Grange, Sheffield, September 2nd, 1811, at 8 o'clock

"2nd Picture. Ditto on September 17th.

"3rd Picture. Ditto on October 5th.

"Can you kindly tell me if this comet has a recognised name?"

He received the following reply:

"It does not appear that any name has been specially assigned to the Great Comet of 1811. It appears to have been discovered on March 26th, 1811, by Flaugergues, and to have remained visible for the exceptionally long period of seventeen months. It is said to have been conspicuously visible in the evening of the autumn of 1811, and it had a tail twenty-five degrees long and six degrees broad. Doubtless the very interesting pictures by your grandfather to which you refer were taken when the comet was at its best. It appears to have a period of about three thousand years, so those who are living in the forty-ninth century may hope to enjoy another apparition. Considering the dearth of comets visible to the naked eye in recent years, it is interesting to note that there was a second comet which appeared in November of 1811, and that in 1813 there were also two bright comets."

One of his oldest friends, a clergyman who was a confirmed bachelor, having expressed certain views as to marriage with a deceased wife's sister, Sir Robert wrote in playful vein as follows:

"I am surprised at you sending me such a thing. What on earth do you know about the deceased wife's sister? Wait until

you get the one sister first of all, and then write to ask my opinion. Perhaps you are like the man in Ireland whose wife was a confirmed invalid. He went to his rector to know if he mightn't marry his wife's sister. 'What do you mean,' said the rector, 'by such a question—have you not got a wife already?' 'Yes, your riverence, but sure, I hear how thim lawyers say a man may marry his *diseased* wife's sister'!

"I am sure I don't know why a man like you, who has not got a wife at all, should suddenly become so anxious to get two. I have a great mind to send your letter on to the Bishop!"

On one occasion he was asked to compose a few lines which were to be entombed in the foundation-stone of an American observatory.

Dr. David Todd, of the Amherst College Observatory (Mass.), wrote as follows (May 28th, 1903):

"The building of our new observatory has progressed so rapidly that we shall lay the corner-stone on June 23rd (Tuesday of Commencement Week). Our Board of Trustees would greatly appreciate it, if you could send a brief word of greeting, to deposit with the other papers in the bronze box which will be sealed in the corner-stone on that occasion."

The reply was in the following terms:

"Observatory, Cambridge, June 9th:—Your very kind letter has given me the one chance in my life! I have long despaired of immortality. Now I see it unexpectedly offered me. With what gladness do I accept the opportunity!

"Yes, please, do lay this letter in your bronze box, which is doubtless as strong and enduring as the occasion requires.

"I look through the ages. I see the Amherst College Observatory for many a decade, for even certain centuries, discharging its noble function of contributing to our knowledge of the Universe. I see it a venerable pile with great traditions, and, remembering the westward course of Empire, I see, I must see, this great Institution passing into decline; I see it even as a ruin, and in thousands of years I see it mouldering into decay.

"Then after yet further immense ages, I see a new Ice Age approaching. I see the great ice sheet rearranging the materials of civilisation. Looking still further, I see the ice sheet vanish. I see the fairest parts of our earth warm again with sunshine, glowing with flowers, and occupied with new races of inhabitants as much advanced beyond man, as man is beyond his arboreal ancestors. I see some future geologist exhuming an astonishing object from boulder clay perhaps a thousand miles from Am-

herst. I see him at a specially summoned meeting of the Great World Academy, forcing open a bronze chest of indescribable antiquity. I see him with trembling hands raising from it a crumbling mass of archives. I see the archæologists crowding around, striving to decipher inscriptions in unknown symbols of unknown antiquity.

"I would fain hope that at last they may discover how a British astronomer once sent to his friends and colleagues across the Atlantic a heartfelt message of sympathy and good will, expressive of his best wishes for the success of the new Amherst College Observatory."

He wrote of Mr. Lecky and Dr. John Purser in a letter to Mrs. Millington (October 25th, 1903):

"I have just lost two friends; it is hard to say which I respected the most. They are Lecky and John Purser. I have known each of them for forty years, and though of late I have not seen John Purser very often, yet I do not think that much interfered with our mutual regard. They were very nearly my contemporaries—two or three years senior. It was a big difference when we were in College, but it is not much now, with us old people. I am recalling all day a line in one of Lecky's poems (most people know him only as an historian):

"'How hard to die; how happy to be dead!'

"The character of each of the men was even more remarkable than his attainments. I shall sadly miss Lecky's gracious presence in the Athenæum."

On September 17th, 1905, he wrote to the Rev. H. B. Swanzy:

"The enclosed copy of extracts from the Churchwardens' Register at St. Mary's, Cambridge, is no earthly use to me, but before pitching it into the waste basket I send it on to ask you to do anything you like with it provided I never see it again.

"It is beyond me to conceive why any mortal should care to know (as on p. 56).

"'Item for iij vnces of ffysseman rebyn at xijd pe vnce.' But I suppose this will amuse somebody.

"Another objection I have to the book is that I can get up-to-date accounts which are just as unintelligible. It is interesting to note that these old churchwardens at St. Mary's have living descendants, who keep the same style of books. I enclose a bill I had yesterday. Perhaps you will kindly return it to me, not so much on account of its intrinsic merits as because if I do not produce it I shall lose the amount."

Lowndean Professor at Cambridge

The bill enclosed was as follows:

"1905 Sir Robert Ball.

Observier.

August to Mr Walker Repren the feance.

the 7	One posts an spures.	3 - 6
	An slaits on gait.	2 - 8
	time one Day 8 houres.	4 - 0
	5 houres the next day.	2 - 9
	tar an naills.	1 - 3
	5 laider rounds.	1 - 6
the 8	new repren the barrow whel new spoaken an new tyre on.	4 -10
		1 - 6

Paid to Mr Walker septem the 16."

His friendship with Sir Oliver Lodge is revealed in a letter dated May 11th, 1906:

"MY DEAR OLIVER,—I think I have known you long enough and I certainly have liked you well enough to venture on this liberty. You will, I hope, give me a Robert for my Oliver. . . ."

He spent many pleasant days at Greenore as the guest of Lord Rathmore. The company generally included the late Lord Justice Fitzgibbon, Mr. Justice Ross, the late Sir Thomas Snagge, Sir Charles Ball, Bart., F.R.C.S., and many others. Here is a typical letter of invitation to one of these parties which he received while in Switzerland (August 16th, 1907):

"Your brother writes to me that you are 'in hiding' and have forbidden the forwarding of letters from home, but he has at the same time sold the pass by giving me your address, and so, lest a note I send to your Cambridge abode should not reach you, I fire this further missile at you over the mountain barriers of Switzerland, for the purpose of telling you that I hope to have a little golf and a bridge * party at Greenore for about a fortnight, beginning on Sept. 4. You will be most welcome if you can manage to give me that pleasure. Your brother has promised to join us on the 4th, so do come, like a good fellow, and stay as long as you can."

* My father was not, however, a bridge player.

Mr. Justice Ross made poetical allusion to the presence of the two brothers at one of these gatherings. The following are a few of his verses:

The Prior sent his message,
And in answer to his call
There came the great twin brethren
Who bear the name of Ball.

One holds aloft the famous lance
That lays Appendix low;
The other is on friendly terms
With all the stars that glow.

His friend is great Arcturus,
His chum Aldebaran.
Both Cygnus and Orion swear
There lives no greater man.

They say that stately Vega
With jealousy grows dim,
When sly and coy Capella
Is winking hard at him.

My father was warmly attached to Lord Justice Fitzgibbon, who had been a playmate of his youth. He wrote to Mrs. Millington shortly after the death of the Lord Justice (October 15th, 1909):

"Only the day before I saw you I played a bright and pleasant game of golf with Lord Justice Fitzgibbon, and now, alas! It was the fifth time I had stayed with him at Lord Rathmore's delightful gatherings at Greenore, and the old affections had revived, and I am truly mourning the loss of a friend who was a great and good man. He had been ailing somewhat, and it did occur to me once or twice that his intense energy was unwholesome.

"You cannot imagine the bright and happy friendliness at those gatherings; but the light of them has now gone out. There is not a soul in the world with whom I can now talk about the Walkers (Hennie and Roger) who lived next door to us in Granby Row, or about the Wilsons in Temple Street. I do not know when a death has occurred which will tug at the heart-strings of so many."

His admiration for Lord Kelvin knew no bounds. Writing to Mrs. Millington (December 19th, 1907), he said:

"'Know ye not that there is a prince and a great man fallen this day in Israel?' These words have been incessantly in my

mind for the last forty-eight hours. No death which has occurred since that of Darwin has impoverished the world as has the death of Lord Kelvin. He was a good man as well as a transcendently great man. No more nobly spent eighty-three years were ever lived by mortal. Always kind, always hard at work, always the brightest and most inspiring example to all. Huxley once truly said of him: 'Gentler knight ne'er broke a lance.' With equal truth Oliver Lodge said that he held it a high privilege to have lived in the same generation as Kelvin!

"This tremendous event has thrust other things from my memory."

Dr. Maurice Hime wrote in 1908 to inquire whether he was not right in assuming that the appearance and the reappearance of comets are subject to certain laws, known or unknown, and not the result of mere chance. The reply was as follows:

"As to comets, we expect a comet in 1909-1910. It is the famous comet of Halley, and we know it. Astronomers know its orbit and its period of about seventy-five years. We have, none of us, much doubt that it will reappear in two or three years, though we cannot say at this moment whether it will be visible in our hemisphere. Still, there is nothing of chance in this; more perfect calculations would settle it all.

"But, as old Kepler used to say, 'There are more comets in the sky than there are fishes in the sea,' and there are probably millions of comets of which we know nothing. Some of them turn up every year; and owing to our ignorance—but only our ignorance—it is a mere chance when a comet turns up—to-day, next week, next month, next year."

Dr. Bernard, Bishop of Ossory (who was then Dean of St. Patrick's), wrote to him in April, 1908:

"A friend tells me that he has been informed on good authority that when Swift made his wonderful statement in *Gulliver's Travels* (Pt. III., *A Voyage to Laputa*, Ch. 3) about the number of satellites of Mars and their periodic time, he was not merely romancing, but writing down what some man of science had told him. I feel sure this is not the case, and would be very glad to have your view."

The reply was as follows:

"No doubt Kepler interpreted Galileo's anagram about Saturn as a triple object to mean that Mars had two satellites. We are told that Micromegas (1752) *saw* them, but Voltaire obviously borrowed this idea from Swift. Cyrano de Bergerac seems also to have predicted them in the same way as Swift.

"But it is, I believe, quite certain that these are all random guesses. It is impossible that they could be seen with instruments of a date earlier than that of the famous telescope at Washington by which they were discovered in 1877.

"No doubt the notion that Mars had satellites was suggested by the consideration that

Venus had no satellites.
Earth ,, 1
Mars ,, *x*.
Jupiter ,, 4.

"It did not require any great genius to say that *x* was probably 2. It is absolutely certain that no one predicted the periodic times, and the most astonishing 'shot' in the whole of science is Gulliver's statement that the period of one of these satellites was so little as ten hours. Had Swift consulted an average astronomer he would have been told, 'Oh, yes, certainly, let Mars have two moons. That is *quite* reasonable, but the ten-hour period is preposterously short. Make it ten days and it will also look quite reasonable.' The fortunate circumstance was that Swift drew on his own genius and not on the scientific conventions.

"My own theory is that Swift wrote (under Arbuthnot's advice) ten *days*, but by a clerical error ten *hours* was printed! The true periodic time (under eight hours) is, of course, unique in the Solar system.

"What a wonderful chapter is that on the Grand Academy of Lagado! The first University for research! The 'Sunbeams from Cucumbers' embodies the great doctrine of the Conservation of Energy, and the Professor who was 'Condensing air into a dry tangible substance' was only the type of the modern Professor Dewar, who has done exactly the same thing!"

My father had no sympathy with the anti-vivisectionist. Writing to Mrs. Millington on November 9th, 1909, he said:

"Stephen Paget made a very good speech here on vivisection, in which he spoke of the persecution he endured, and the stones that were flung at him by the anti-vivisectionists. I was in the chair, and I was much tempted to encourage him by reminding him how the stones that were thrown at another Stephen 2,000 years ago had made him immortal!"

Many people having written to Sir Robert to inquire whether Halley's Comet was likely to be a dangerous visitor, he wrote to the *Times* on February 10th, 1910:

"I have received multitudes of letters relating to the comet. So many have expressed alarm as to the possibility of collision,

that I venture to send you the reply I have posted to-day to one anxious inquirer. It was as follows:

"'MY DEAR ——,

"'A rhinoceros in full charge would not fear collision with a cobweb, and the earth need not fear collision with a comet.

"'In 1861 we passed through the tail of a comet and no one knew anything about it at the time.

"'For a hundred million years life has been continuous on this earth, though we have been visited by at least five comets every year. If comets could ever have done the earth any harm they would have done it long ago, and you and I would not have been discussing comets or anything else.

"'I hope this letter will give you the assurance you want. So far as I can learn we may be in the tail of Halley about May 12th; and I sincerely hope we shall.

"'I think Sir John Herschel said somewhere that the whole comet could be squeezed into a portmanteau!'"

This letter was copied far and wide. It was reproduced in many Continental newspapers, and it even reached the Indian Empire. A Parsee gentleman told me that its appearance in the Indian papers did much to allay the dread with which the natives regarded the approach of the comet.

His attitude towards Mr. Steele, his brother-in-law, is expressed in the following letter (October 31st, 1904):

"I think I must owe you many letters. I don't like to phrase it that way, for, if you will allow me to say so, you are one of those to whom it is always a great pleasure to me to write. Perhaps you would not think so from the infrequency of my letters. Did not Goldsmith say, in writing to a friend, that no turnspit dog ever went to his task more reluctantly than Goldsmith himself when he began to write letters, but that no turnspit dog ever loved the roast beef he cooked more than Goldsmith himself loved the friend to whom this sentiment was expressed? Thems my sentiments, too, when I write to you."

Mr. Steele read and revised the proofs of nearly all my father's works on astronomy. Writing to him shortly after "The Earth's Beginning" was published, my father said (October 13th, 1901):

"I don't think I ever fully expressed to you all my thanks for your invaluable help about the book. Please accept those thanks now. You will receive a copy in a few days, or it may be weeks, but I have seen the last of it. Next to 'The Ice Age' it is, I think, the best thing I have done. Reviewers will say it is

'worse even than "The Ice Age," if that were possible.' At all events, it will owe very much to your care and loving-kindness, and to your encouragement."

A friend who had returned from a trip to Norway wrote to ask for the loan of a book which would tell him something about the geology of that interesting country. He received the following reply (August 26th, 1894):

"I don't know any other book but 'Forbes,' which I have. I have been looking up other sources, but though I can find plenty about the coins of Norway, the oysters, and the prisons, I can see nothing as to the geology. Even Baedeker (as you doubtless have perceived) is silent on the matter.

"I do not wonder you were struck with those splendid diagrams of geological action which the fjords present. I, too, was greatly interested in those mighty banks. They often call them moraines, but not very correctly, for what I saw were often what the geologist calls 'Water Fans,' i.e. accumulations of débris at the foot of the fall.

"The wonderful embankments which you mention are in some cases, at all events, due to two waterfalls from opposite sides generating 'Fans' which meet. Then the lake begins to form, and it gradually washes the materials of the Fans into the shape of a great bank. When the lake grows big it bursts out and the river flows in a cut.

"I have not got Lyell's 'Principles of Geology,' but if you look in one of the late editions, you would be sure to find what you want. I should love to have a long big talk with you on the subject."

Of my father's artistic tastes it may be said that he preferred a faithful reproduction of a beautiful natural object to the greatest picture by the greatest artist. Anyone who ever visited the Observatory at Cambridge will remember the photograph of a wave breaking on a rocky coast, which was to be seen just inside the door. The Lowndean Professor preferred to have his house filled with photographs of sunspots, Niagara, and glaciers rather than to have its walls covered with paintings.

That he did like pictures, however, may be gathered from the following extract from a letter:

"We had a great day at the private view. We saw many lovely things. Alma-Tadema's 'Watching' is exquisite—an oriental girl sitting on a tiger-skin in (of course) a marble hall

with two wondrous necklets of amethysts and topaz! But I am told that the picture is destitute of 'artistic feeling,' of 'breadth,' and of 'spontaneity,' so, of course, I should not have admired it, but I did, and do.

"There is 'spontaneity' enough about 'St. Anthony and his Temptation'! A friend of mine told me he had great difficulty in dissuading his rich father-in-law from buying it. Even his daughter's remonstrances against such a shocking thing in the drawing-room were without avail, until an artist's wife pointed out the real or imaginary defect that the foot of the 'Temptation' was out of drawing. This settled the matter. But the picture is admirable.

"There are lovely things in profusion. I would give everything I have to possess 'Calypso on her Seagirt Isle,' and 'Napoleon's Last Review' of the two children of (who was it?), is the most pleasing picture of the great man I ever saw."

It has already been stated that my father had trouble with his right eye. Before he went to Cambridge he had completely lost the use of it. A few years later he was advised to have the useless eye removed. He announced the acquisition of a substitute to a friend in the following terms (June 30th, 1897):

"I commenced a new imposture on the public yesterday with a glass eye! The last word of the oculist to me was: 'You will *probably* be much more comfortable than you have been for a long time; you will *certainly* be much safer.' I have as yet really had no trouble, nor do I see any reason to dread it. I had to call on a high official the other day on some business for a friend. He had a wig just like ——'s, and he had a set of false teeth like no other human being! As I contemplated these curiosities with a steadfast gaze of my glass eye, the pious thought rose in my bosom, 'We are fearfully and wonderfully made!'"

A few days later he wrote:

"I am now beaming on a delightful world with my glass eye. I shall have an opportunity of displaying it to exceptional advantage on Wednesday next, when I am the guest of a hundred ladies who, I am informed, represent the female intellect of Great Britain. They are inviting to the banquet the hundred members of the other sex who, in the opinion of the ladies, and no doubt in their own, represent the cream of masculine perfection both in appearance and in intellect.

"Mrs. —— came the other day to see whether my glass eye would be endurable or not, and finding that it was (she even

went so far as to say it was a distinct improvement to my previous appearance), she gave me the invitation on the spot! You will remember that Tycho Brahe, having lost his nose in a duel, made a copper nose which both friends and enemies alike agreed in declaring was as good as the original! Tycho said that a future 'Tychonides' would arise who might be worthy of comparison with him. In my sanguine moments I dare to aspire!

"In the opinion, therefore, of the hundred most accomplished leaders of female society, I am one of the hundred handsomest men!"

The summer holiday was generally made the occasion of a family re-union. Here is an extract from a letter in which he urged Mr. Steele to join in a tour in Switzerland:

"Now I am going to bring with me my wife and as many of my six children as can get away. I appeal to you by all the memories of old times; by all the associations of the present and all the prospects of the future, that you will arrange to come too. Of course, the same applies to C. Pitch every thought inconsistent with this scheme to the winds. Grindelwald is enchanting—and as to Davos, I believe there is only one better place, for which, however, I am in no hurry to take my ticket."

The recipient having objected to Davos on the ground that there were too many germs of tuberculosis about, Sir Robert wrote in reply:

"I think that very likely you could do better than go to Davos so far as Swiss scenery is concerned. So perhaps it would be better to leave yourself free after Grindelwald.

"I don't quite appreciate your use of the word 'tuberculosed.' The fact that L. finds he can run a party there year after year, and that M. went with him last summer, and said he would like to go again, shows me that for a little stay such as we want Davos is a suitable place. As to your remark about the tubercles, you seem to forget that if you are exposed to danger, so shall I be. You remind me of a neighbour who came to remonstrate with me *three times* on the ground that she believed our dog was mad, and that therefore there was a danger to *her* and *her children!*

"I could not but point out that great as was the temptation to keep a mad dog for the purpose she dreaded, yet I declined to do so because it might involve some risk to my own wife and family, not to mention to myself!

"We simply pine for the 'Continong.' Everyone knows its beneficent effect on health; as Wordsworth says so beautifully:

'Mrs. Gill is very ill,
And nothing will improve her,
Until she sees the Tuileries
And waddles through the Louvre.'

"I would not recommend you to stay behind for my son Charlie,* though I much appreciate your kind thought, and he would be glad of your company. But the fact is that the right to travel the next day on these tickets is a little obscure, and I have prepared Charlie for the demand for extra moneys *en route*. I have counselled that he should preserve a stolidly stupid demeanour and pretend not to understand the French ticket-takers (the pretence will not be difficult). I have even authorised him to resort to Irish blasphemy if he cannot otherwise escape."

If Mr. Steele were not one of the holiday party, he nearly always received full written accounts of all that happened. When staying at Waterville, Co. Kerry, my father wrote (August 14th, 1905):

"This is a lovely place in fine weather, such as the last few days have been. It is full of interest in every way. The river is round the house, and the lake, the mountains, and the Atlantic are all close by. Within sight of the windows of our bedroom is a 'Druidical sacrificial stone' (so-called) and a miniature Stonehenge—a really wonderful monument. We drove to see Staigue Fort. It is only the most conspicuous of a dozen other similar old forts in and about here. Your sister has developed into a first-class fisherwoman. Hooked, played, and killed three fine trout! Her method of playing is as novel as effective. She simply backed up the mountain side until the fish gave in and surrendered to the landing-net! If I am not a fisherman, I have at all events taken out a licence for a salmon rod, and in company with a bishop I am going to spend next Friday in the traditional apostolic occupation. We shall launch our boat into the deep Lough Currane.

"As I write a carriage comes down the hill bringing guests. They are the Misses O'Connell of Derrynane, the great-granddaughters of Dan himself, whose funeral (as I shall be sure to tell them) I saw when I was six years old.

"I received a drubbing at golf this morning from the rector here, who plays a good game. The links are situated on the seashore, with a magnificent surrounding of mountains."

* Charles Rowan Hamilton Ball, L.R.C.P., M.R.C.S.

Of the "Life of Cardinal Manning," he wrote on March 11th, 1899:

"I have just been enjoying one of the most interesting books I ever read; the Life of Manning! Of course, this is a stale matter now, but my reading is always belated. What a great drama the whole thing is, and the biography is, I think, the best I have ever read. The whole thing would make a great play, only that there are no females in it. Not that I think much of Manning himself, or, indeed, for that matter, of any one character in the book, but it is wonderful. The fight between the Infallibilists and their opponents is grand!"

He wrote to his son Robert on May 21st, 1901:

"Did you ever read Mill's 'Political Economy'? It is a charming book. I would not allow anyone to be a candidate for Parliament who could not pass an examination in it."

As all the world knows, a shower of Leonids was expected in the autumn of 1899. My father, who had a vivid recollection of what he saw at Parsonstown thirty-three years before, looked forward to the enjoyment of a similar spectacle. He told his friends to do the same. In the early part of November numerous people sought his advice as to the best place from which to see the meteors, and the best time to maintain a vigil. Indeed, the callers at the Cambridge Observatory became so numerous that Sarah, the parlourmaid, was at pains to protect the Lowndean Professor from too frequent interruption. He was greatly diverted when he heard of the advice which she gave to one group of visitors. Having been told that "Sir Robert was not at home," they ventured to ask the maid if she happened to know what time the meteors were expected. "I think you had better sit up all night," she replied.

On the night when the meteors were really expected a kind of informal "at home" was given at the observatory. The chief assistant, Mr. Arthur Hinks, F.R.S., made the necessary arrangements. Writing to him on November 17th, Sir Robert said:

"I herewith enclose a cheque, being in liquidation of the refreshment account in connection with the Leonids.

"I am glad indeed that you divined my wishes so truly by taking upon yourself to order for my account what was necessary to sustain the faculties of Herschel's party. I do love to have people who will assume little responsibilities like that when

the proper occasion for doing so arises. In fact, it gives me much heart-searching to think that I had forgotten to speak to you about it until it was too late for me to do anything. It was therefore a great relief to find that you had done so.

"But lest there should be any doubt as to my future wishes, I now hereby authorise you to order a sumptuous supper for all and sundry who will attend at the observatory on the occasion of the next meteor shower in the year A.D. 1933! I will pay the bills, no matter what they are. I will only leave you the trouble of discovering my address!"

Writing to a friend on November 23rd, he said:

"The meteors seem to have been a fiasco! The only person who saw them was a policeman, but that was on the wrong night! I am assured that Constable B 9999, on whose testimony the phenomenon is recorded, is a teetotaller. The only points that I have been able to collect with certainty are that he was sitting on a gate at the time, and that he saw hundreds of stars; otherwise the account is a little obscure!"

When Queen Victoria paid her visit to Ireland in 1900 my father and uncle remembered that they owed something of their early advancement to the generosity of the Crown. They wrote as follows on April 4th, 1900:

"May it please Your Majesty,

"Your Majesty was graciously pleased by Queen's letter in the year 1857 to grant unto our mother, Mrs. Amelia G. Ball, a pension in recognition of the services rendered to science by our father, the late Robert Ball, LL.D., which she continued to receive until her death in 1895.

"We her surviving sons trust it will not be considered presumptuous if, upon the occasion of Your Majesty's visit to our native city, we take the opportunity of tendering the expression of our devoted loyalty and our heartfelt gratitude for that timely aid rendered so many years ago to our dear mother in her distress, which, as she often told us, largely assisted her in providing us with our education.

"We have the honour to remain,

"Your Majesty's obedient servants,

"ROBERT S. BALL,

"Lowndean Professor of Astronomy and Geometry in the University of Cambridge; late Royal Astronomer of Ireland.

"CHARLES B. BALL,

"Regius Professor of Surgery, University of Dublin."

They received the following reply:

"VICE-REGAL LODGE,
"DUBLIN.

"*April 7th*, 1900.

"DEAR SIR,

"The Queen was greatly touched by the letter which you, jointly with your brother, Sir Robert Ball, addressed to Her Majesty.

"I am desired to thank you for the kindly and loyal sentiments which it contained.

"The Queen feels that Mrs. Ball must have been proud in the thought how more than amply recompensed she had been for whatever provision she had been able to make for the education of your brother and yourself by the eminent positions which, by your distinguished talents, she lived to see you respectively occupy.

"Believe me, Dear Sir,
"Yours very faithfully,
"ARTHUR BIGGE.

"C. B. BALL, ESQ., M.D., F.R.C.S.I.,
"Regius Professor of Surgery, University of Dublin."

Mr. Steele having written to describe a visit of Queen Victoria to Ireland, Sir Robert wrote on May 17th, 1900:

"Many thanks for your long letter, but I felt I could not answer it before. Your swagger about the Queen was so awful, that it was wholly impossible for me to stand up to it, until I had had a private and confidential conversation with a King! This condition having been now satisfied, I am able to do what I have been long panting to do, and that is to reply to your letter.

"His Majesty of Sweden has been here getting a degree, and we had a private tea-party at the Provost's lodge. He told me that he had sat up till two o'clock to see the shooting stars, and shaking me by the shoulders, he said, 'Why did not they come off?' One of the ladies who was there said, 'Oh, we hold Sir Robert Ball responsible for that disgraceful failure.' Then the King came to the rescue. 'There are three classes of persons,' said he, 'who are constantly abused, most unjustly. They are politicians, kings, and men of science! Now I have been most shockingly abused all over the Continent for my friendship to Britain, but friendly to Britain I am, and friendly to Britain I will remain.' One lady said to him of Sweden, 'I hope your Majesty enjoys the climate of Rochampton; I have frequently seen your Majesty riding on your bicycle in the neighbourhood.' 'Oh, no, no, no, no,' said Oscar (not Browning, of course, though

he was there, I need hardly say), 'I never was on such a thing in my life; the person you saw on the bicycle was my chief steward.' But his Majesty was very jovial, he clutched each lady by the arm as he spoke to her, and finally made a pretty little speech when he went away, saying he hoped we should all meet again.

"Last night I dined at the Authors' Club. I wish you had been there. It was the annual dinner of the Authors' Society, and there were about three hundred present. Pinero was in the chair and made a wonderful speech, in which he spoke of the condescension of the Society of Authors in admitting as their chairman a poor relation who was a mere dramatist. He worked this point very amusingly by an elaborate description of a poor relation being asked to dinner. After returning to his lodgings, and sitting down before the gas stove he gazed on the unsympathetic asbestos and realised his lot. The diction was perfect and the manner consummate, but it was entirely that of an actor who had studied his book perfectly. The other speakers of the evening were Anthony Hope, who was amusingly chaffed by Pinero in his double capacity as Mr. Hawkins and Anthony Hope. He told us of a young lady acquaintance of his who had an eager, if somewhat uninformed interest in current literature, and who asked him if he knew Mrs. Craigie. Yes, he said, he had that privilege. 'Then tell me,' said this young lady, 'why does she disguise herself under the name of Anthony Hope?' a beautiful illustration of a muddle which brought down the house! But by far the best speech of the evening was made, it goes without saying, by an Irishman, Mr. Bernard Shaw. You probably know his works. I never heard of him before. He amusingly described the reason why he went into literature. It was because he disliked the hard work attached to any honest calling. He then spoke of the poverty of authors, and said that it was insult added to injury to have that poverty mocked by an opulent playwright. My seat at the banquet was a distinguished one. I sat between Holman Hunt and Madame Sarah Grand."

His Majesty the late King of Sweden was not the only royal personage with whom my father became acquainted in his Cambridge days. He also met the Alake of Abeokuta. Of the visit of this potentate to Cambridge he wrote to Mrs. Millington (June 11th, 1904):

"But the Alake of Abeokuta, whom we met at a party at the house of Baron von Hügel, has won all hearts. In Ireland we should describe him as 'a jolly old cock.' He is full of interest in everything. I had a long chat with him through the inter-

preter. Though blacker than this ink, he knows everything, and was specially interested in seeing the rooms in Trinity occupied by Macaulay and Thackeray and Newton and knew their fame and works. He was gorgeously dressed in native costume, with a white cotton head dress, and a white cotton lizard on the top as the emblem of sovereignty. His pantaloons were short enough, however, to disclose a bran new pair of patent leather boots evidently just bought at ——, which, with the tags standing out straight behind, rather spoiled an otherwise picturesque effect. The Dean of Westminster brought us down this story, which you will like. The Alake paid a visit to the Abbey, and the Dean told the organist to play such airs as, while compatible with the sacredness of the locality, would still be lively enough to provide something suitable to tropical African taste. So the music went on, when suddenly it occurred to the Dean to ask through the interpreter if there was any air which the Alake would particularly like. 'Yes, "Abide with me,"' was the immediate reply. Word was sent to the organist, who, without stopping, gradually transformed whatever he was improvising into what was asked for, and as the divine strains swelled through the Abbey the tears streamed down the black royal countenance! Yes, we did all of us like the Alake, and he would be welcome here again."

In April, 1904, my father's "portrait" appeared in *Vanity Fair* over the title "Popular Astronomy." Mr. L. E. Steele having been invited by the editor to prepare a brief account of the subject of the cartoon, wrote as follows:

"Sir Robert Ball.

"Not having been consulted as to the place of his birth, he nevertheless selected Dublin; whence it comes that his humour is not Anglo-Saxon. Yet an English school and an English university have done their utmost to suppress it. Being a kind-hearted man, he tolerates the Saxon, yet he disapproves of free breakfasts for school children.

"Although a portly man he is said to have heard 'the Music of the Spheres' (*vide* Shakespeare).

"With a passion for horses, and being a recognised authority on 'Screws,' yet he has never been known to ride to hounds. Notwithstanding that he golfs, his language is beyond reproach.

"He has been known to farm, a pursuit which, however, he has now delegated to his wife; and has expressed his opinion on the merits of 'decorticated cotton cake.' His acquaintance with 'roots' is strictly limited to the '*genus mathematicum*.'

"He has recently acquired a taste for politics and is the doyen

of a Cambridge caucus. Yet Sir John Gorst is said to have a high opinion of him! He is a man of 'letters,' being an LL.D., an F.R.S., an F.R.A.S., an M.R.D.S., and an M.R.G.C.* He is thought to have written books, and is believed to have lectured; yet he is an admirable after-dinner speaker!

"Being a confirmed Darwinian, he has, with the assistance of Mr. Fox-Davies, traced his descent from a *Pithecanthropus Alatus* resident in Youghal. Hence he is a vice-president of the Dublin Zoological Gardens."

After the cartoon had appeared my father wrote:

"Many thanks indeed for your most kindly and genial words as 'Jehu Junior.' Even though, as you tell me, they have mangled some of your points, yet from the excellence of them as they stand I can conjecture how sublime they must originally have been. The family approves of the libretto, but some of them are fit to be tied about the portrait. I don't quite know what sort of Adonis they expected. But it seems to have given much general satisfaction. I have heard of it from dozens of people."

He was deeply interested in the career of a young Russian who had a remarkable success in the mathematical school at Cambridge. On January 5th, 1906, he wrote:

"I have been terribly busy for many weeks. The appearance of my book by no means brought me the leisure I hoped. For the first time in my life I have got into the hands of the Jews! A Russian Jewish exile, Brodetsky, who came to London in 1893, brought with him a child of five, who by miraculous genius became *Senior Wrangler* here last year, his father being still a pedlar in Whitechapel. This youth came to me to learn mathematical astronomy. He is the most wonderful genius I have ever come across, and in order to do him justice I have been working at the highest pressure for three months, and shall have a couple of months more at least. But the work is most congenial and indeed delightful. The Maccabean Club, a Jewish society of the leading intellectual and professional Jews in London, gave a dinner in honour of Brodetsky and invited me. It was most interesting in every way, and at the dinner was the worthy father, and when we were told the miserable story of his expulsion from his native land fifteen years ago, we could not help congratulating him that the function of the evening showed him that the cloud had its silver lining.

"*P.S.*—Brodetsky's career is a superb answer to the twaddle about bringing the Universities within reach of the working man. If the working man has genius, the Universities are *at present*

* Member Royston Golf Club.—Ed.

within his reach. If he has not genius there is no kindness in bringing him to the University at all."

On June 3rd, 1906, he wrote to Mr. Steele:

"Do you remember when a Dublin newspaper, in a glowing description of Guinness's brewery, said they produced so much porter that it needed a pipe *not only* three inches in diameter, but more than half a mile long to carry the liquor from one part of the buildings to another?

"The same hand has now been turned on to describe the Madrid tragedy. Witness the following passage:

"'We shall have to wait for some little time before the real extent of the outrage can be ascertained. The *Epoca*, however, announces that thirteen soldiers and eleven civilians have been killed, and that twenty-six soldiers and twenty-four persons have lost their lives seriously. Their Majesties mercifully were spared, but the infernal machine carried death or maiming for life through the ranks of a crowd on holiday-making intent. Seventy-four persons have lost their lives, and fifty others have met with injuries which in some cases will terminate fatally.'

"Will you, for the credit of Irish journalism, answer me the following questions:

"1.—How many people lost their lives *seriously?*

"2.—If a soldier is not a person, what would a policeman be?

"3.—Distinguish clearly between the eleven civilians who were killed and the twenty-four persons who lost their lives seriously?

"4.—Show arithmetically that thirteen soldiers and eleven civilians *plus* twenty-six soldiers *plus* twenty-four persons (seriously) equal seventy-four."

Some account of one of his visits to London is to be found in the following letter (April 22nd, 1906):

"We wanted you badly in London. I paid four visits to the Natural History Museum and was more and more delighted with its wonders. Especially was I pleased to see the fossil stomach of an Ichthyosaurus showing the pebbles which this animal used to swallow for digestive purposes, thus again illustrating the connection of the reptiles with the birds. In another specimen a group of fœtal Ichthyosauri show that this beast was viviparous. Then, too, I never before studied the anatomy of the *legs* of a boa constrictor! Nor did I ever before know how wonderfully the cuckoo can mimic in her own egg the varied characters of the eggs in the nest she may happen to have chosen. But I didn't mean to worry you with all this. For the sake of old times I had to make one midnight visit to ——, whose shops are now in many cases glorified beyond recognition.

"Then, too, I wanted you for big trips at cheap fares on the Mobuses (Mobi?). I had a grand run to Hammersmith, a place I had never even seen! It is a part of my religion never to go to the Boat Race or to Lord's."

Mr. Steele, who is an Egyptologist, would sometimes write of matters which were of interest to an astronomer. On May 5th, 1910, he wrote:

"The Great Pyramid was, as you know, built by King Khufu, better known by his Greek name of Cheops, of the fourth dynasty.

"His date, as given by Petrie, is 3969—3908 B.C., and the building was erected at some time between those dates. Tradition and indeed custom point to the building having been commenced upon the king's accession, and Herodotus tells us it took twenty years to build. If this be so, 3949 B.C., or let us say 3950 B.C., saw it practically completed—I am afraid this is the closest approximation possible. The astronomical theory of the ascending passage having pointed to a particular star has been, I believe, abandoned by all except certain faddists."

Sir Robert wrote in reply (May 9th, 1910):

"Many thanks. But it appears to me, as it did to Sir John Herschel and to R. A. Proctor, that the long passage in the Pyramid *did* point to α Draconis at lower culmination, about 3500 B.C. I do not see how anyone can dispute this. But I would like to be kept right. By whom has this view been abandoned? If you will look in Herschel's 'Outlines of Astronomy, or in Proctor's 'Great Pyramid' (the former for choice)—it is only a page or two—I think you will see it is a mere matter of figures depending upon the precession of the equinoxes (about which there is no shadow of doubt) that at the time referred to α Draconis *was* the Pole Star and *was* (on the observed value of the inclination of the passage) visible at *lower* culmination from the bottom of the passage. Show me the man that denies this and let me at him! That's all!"

His correspondent apparently took the view that the fact that α Draconis was visible from the bottom of the passage did not fix the date of the Pyramid. He wrote on May 10th, 1910:

"Many thanks for your letter. I have read Proctor's book, and shall look up Sir John Herschel's reference; but I did not, nor would I dare to, deny the *fact* that α Draconis could have looked down the Entrance in 3500 B.C. $\pm$ fifty years—that is beyond yea or nay.

"To say that *therefore* the Pyramid was built within these years is another matter—and that is what was in my mind when I wrote.

"The earliest well-ascertained date in Egyptian chronology is 1587 B.C., that is, the beginning of the eighteenth Dynasty. From that backward the calculations depend on dead reckonings, that is, on the regnal years as given in the lists of kings totted, *and* on the Sothic periods in conjunction with one reference in a sixth Dynasty record; and these have been proved by Petrie to check each other to within about a hundred years. So that a margin of error of one hundred years must be allowed in the dates *anterior* to the sixteenth century B.C. On these grounds the late date 3500 B.C. won't do, and it is nearer the truth to say that the Great Pyramid was built early in the fourth millennium B.C.

"I don't think Proctor knew, and certainly Herschel did not, what (I believe) Petrie disclosed by his accurate measurements, namely, that the Entrance is twenty-four feet out of centre, that is, it is nearer by that distance to the east side than to the west. I thought that this might upset the astronomical theory that α Draconis did look down the passage, but that outrageous and soul-destroying and unreasonable assumption that 'parallel lines meet at infinity' is hurled at a common-sense person, and he is forced to admit that *that* small shift of position would not alter the visible position of the star in relation to the Entrance! I am afraid the parallax is *somewhat* greater than that!

"Is it not certain that the ancients could easily have oriented their buildings by a simpler method than by the stars? I fancy they did it by the shadows.

"To go to another subject—I have only now got hold of 'Coke of Norfolk,' and you did not say too much for the book. May I in return suggest reading 'Through Afro-America,' by William Archer. It is a most interesting work on the negro problem in the States and elsewhere.

"Another most interesting book I have lately read is 'Egypt in America,' which deals with the marvellous buildings of Mexico and Yucatan, and incidentally with modern life in these countries—the latter so atrocious that I have since sold out some shares in a Mexican railway."

A friend having made inquiries about a book he thought he had lent to Sir Robert, my father wrote as follows:

"No! I did not borrow 'Barry Lyndon' from you. I wish you could find the culprit. Lending books is death and destruction. I lent some valuable books six months ago to an Indian student, Ram-something or other. He asked might he take

them away with him under solemn promises. Now I hear the poor fellow is ill—indeed dying, I was told, in the south of France. The worst of it is the books we lose (i.e. lend) are generally the ones we can least spare. I have lots of books of which I have been sick of the sight for half a century. I will try lending them, I think.

"I had a pleasant dinner at the Whitefriars Club on Friday. It consists of literary City men, and the guest of the evening (who was R. S. B. last Friday!) has to open a discussion on some subject. I took 'Wild Beasts' as the theme. We had, to my consternation, Chalmers Mitchell, Secretary of the London Zoo, present. However, all went well, and we had a fine evening of it."

CHAPTER X

LECTURES ON ASTRONOMY

I.—*How Sir R. Ball began his career as a lecturer*

IT is clear from a perusal of the notes and papers which my father collected for the purpose of writing his "Reminiscences" that he had it in mind to give a connected account of his experiences as a lecturer. Although he was unable to write the full story of this important part of his career, he did leave behind him certain memoranda which are of considerable interest.

So far as I have been able to ascertain, his first attempt at anything in the nature of a lecture was when he was an undergraduate in Trinity College. In the year 1859 he read a paper before the Philosophical Society on "The Gulf Stream," that "river in the ocean" of which he often used to speak in after life. As President of the same Society he delivered a learned address at the opening of the session 1860-61.

His first appearance on the public platform took place on February 4th, 1869, when he lectured to the Belfast Athenæum on "Some Recent Astronomical Discoveries." With reference to this lecture I found a note among his papers: "I made 14s. This is the first sum I ever made by such lectures! The Secretary offered more, but I refused anything except expenses, and the sum they sent exceeded my expenses by 14s. There is an excellent account of the lecture in *The Belfast News Letter,* February 5th, 1869."

On February 13th, 1869, while he was Professor of Applied Mathematics and Mechanics at the Royal College of Science, he was invited to give a lecture in the first course of the annual "Afternoon Scientific Lectures," which ever since have been a recognised feature of the varied work of the Royal Dublin Society. In response to this invitation he gave a lecture on April 17th, 1869, entitled "Nebulæ," his subject being illustrated by a reproduction on a large scale of Lord Rosse's

famous picture of the Great Nebula in Orion. What he said was subsequently printed. To read it now is to realise that even in those early days the power of exposition which afterwards rendered him famous as a public lecturer was already in being. In his endeavour to give those who listened to him some faint idea of the distance of the Great Nebula he said: "It is believed most firmly by those competent to judge that the nebulæ are plunged in the profundity of space to such an appalling distance that the light from some of them takes centuries to reach the earth. Their distances may be much greater, but it cannot be less than this. We see these nebulæ not as they are, but as they were hundreds of years ago; and were one of these bodies to be struck from existence by the fiat of Omnipotence, posterity for many generations might still observe, measure, and draw the object long after it had ceased to exist!"

I now turn to his own account of his career as a lecturer:

My life at Dunsink Observatory was very quiet. Possibly its chief interest to the readers of these Reminiscences is that it was during this period of my life that I began to make expeditions to England for the purpose of giving public lectures. I shall now explain the circumstances in which I first became known in some degree to the public in this capacity.

It came about more by accident than by design. When I went to Dunsink I had not the slightest idea of extending my work beyond the confines of the observatory and Trinity College. What led to the enlargement of my labours I shall now explain. It may be remembered that when describing my experiences at the Royal College of Science I mentioned certain mechanical apparatus which I had adapted from the system devised by Professor Willis, of Cambridge. Having used this apparatus for illustrating certain evening lectures at the College, they appeared to be so successful that I subsequently undertook to give a course on "Experimental Mechanics." With the help of this apparatus I endeavoured to explain various mechanical laws. I was able to demonstrate some of the elementary principles on which bridges were built, how a crane was able to raise its load, and how a body fell sixteen feet in a second.

The course seemed to do so well that I wrote to Messrs. Macmillan with a view to publication. I received a cordial and

sympathetic reply, of which I was very proud. Indeed, I kept their letter in my pocket for some days to show to my friends when I met them. I looked upon it as an introduction to authorship! As much depended on the suitable illustration of the apparatus, the publishers employed an accomplished draughtsman, who spent some days in the College of Science, and made a beautiful series of sketches of the various contrivances. In due course the book appeared. It was not a very great success; there were many things in it which I afterwards would have been glad to have seen otherwise. But it had a fair sale, and it led to a good deal of correspondence. In particular I received two or three inquiries from places in England and abroad as to where this Willis apparatus could be procured. Professor London, of Toronto, wrote on November 18th, 1872, to ask for my assistance. The most important application, however, came from the Midland Institute at Birmingham.

The Midland Institute has long been known as occupying a foremost position among provincial societies. It has many fields of activity, a large membership, and does most excellent work. I might mention that in 1869 Charles Dickens was elected its first President. Mr. Cresswell, who had charge of the Lecture Department, wrote to inquire where the Willis apparatus could be obtained, and I naturally gave him all the assistance in my power. Shortly after the apparatus was delivered at Birmingham the authorities inquired whether I would come over and show them how to use it, and give some illustrations of the various purposes to which it could be applied. This invitation came in the spring or summer of 1874, just at the time when I had exchanged my position of Professor of Mechanics at the College of Science for that of Professor of Astronomy in the University of Dublin. I felt that it would be a little awkward to give a public lecture on mechanics immediately after I had taken a step which seemed to indicate that the rest of my life was to be devoted to astronomy. I wrote to point out this difficulty. The answer was prompt and to the point. I have not kept the letter, but its purport was something to this effect: "All right; we understand. But why not do this: Come over and give us two lectures on astronomy, stay here for a week, and during that week give us some private lessons on the use of the Willis apparatus?" I accepted this

proposal. And that is how I came to be a public lecturer on astronomy.

That my first public lecture was given in 1874 is impressed on my memory from the circumstance that I chose as my subject a great astronomical event which occurred in that year. The event was the Transit of Venus. Let me explain the phenomenon in a few words. As the planet Venus revolves in an orbit inside that of the earth, and very nearly in the same plane as the earth, it will sometimes happen that the planet comes directly between the earth and the sun. I say it sometimes happens, but the occurrence is very rare indeed. As a general rule Venus, when viewed from the earth, seems to be close to the sun. It seems to be over or under the sun. The appearance of Venus on the sun is very rare.

When one transit does occur there is another eight years subsequently, but this pair of transits is separated by a long interval from the next pair. The transit of which I am speaking occurred in the year 1874, and was followed by another in 1882, but there will be no other Transit of Venus for nearly one hundred years—not, indeed, until 2004—though then there will be another eight years later, namely, in 2012. The interest taken in the transit in 1874 is therefore intelligible. It was one of very great importance in astronomy, as it was believed to afford the best means of solving that grand problem of Nature—the distance of the earth from the sun. It was with this object that Lord Lindsay sent an expedition to Mauritius. Nor will it be forgotten that on another occasion the famous voyage of Captain Cook to Otaheite in 1769 was undertaken with the object of determining a suitable site for observations. The Transit of Venus in 1874 was visible from India and from many other places; but it was not visible from Great Britain. The sun was at the other side of the world during the critical moment when the planet passed in front of it. Nowadays—perhaps because the next transits can only be observed by our great-grandchildren—we do not take much interest in the subject. Indeed, I ought to say that the Transit of Venus, so far as it throws light on the distance of the earth from the sun, is no longer of much importance, as other methods of solving the same problem are now available; and though not of such great historical interest, they are believed to be more accurate. In 1874, however, the transit attracted

the attention of all who took an interest in scientific matters. Thus it was that the subject of my first public lecture, delivered in 1874, was "The Transit of Venus." I endeavoured to show what the phenomenon was, how it arose, why transits occurred at intervals of eight years, and why it was that so many years intervened between one pair of transits and the next. I quoted the memorable passage in which the great astronomer Halley first explained to astronomers that the Transit of Venus afforded a means—till then unknown—of solving the problem of determining the distance of the sun. I told them how Halley stated this, and then recalled the somewhat pathetic words in which, knowing that his earthly course would have run long before the epoch of the transit would arise, he enjoined those who might be then living to spare no pains to utilise their opportunities to the utmost. I had prepared many diagrams, and I had a slide made to illustrate how eight revolutions of the earth corresponded to thirteen revolutions of Venus.

The lecture, I believe, went fairly well. I was entertained most hospitably at the house of Mr. Follett Osler, in Harborne Road, Birmingham. I was also the guest for a few days of Mr. Alfred Elkington. Both these names suggest industries which are deservedly the pride of Birmingham. Mr. Osler, besides being well known as a manufacturer of exquisite glass, had attained fame as a man of science. He was the inventor of an anemometer which bears his name. He was a Fellow of the Royal Society. I especially remember these two pleasant visits. They were the earliest of the many occasions on which I have been most hospitably entertained at houses of kindly people to whom I was unknown otherwise than through the chance which brought me to lecture in their neighbourhood.

In the second of my two lectures at the Midland Institute I described some of my experiences at Parsonstown. I called it "A Night at Lord Rosse's Telescope." At that time the Midland Institute had no hall of its own, and these lectures were delivered in the Masonic Hall. In the interval between the lectures I gave the promised demonstration with the Willis apparatus. This, of course, was a private matter, at which only members of the class were present. In the same week I also went, by invitation, to the Potteries Mechanics' Institute, Hanley. There, too, I gave a lecture, and before going home

I also lectured at Gloucester. This was the first of my lecture tours.

During subsequent years I made frequent trips to Birmingham. One of these visits should be especially mentioned. In 1881 a new hall was built by the Midland Institute. They paid me the great compliment of asking me to deliver the inaugural lecture on October 24th, 1881. It was upon this occasion that I first gave the lecture which was perhaps more widely known than any other I ever delivered. Many years before my valued friend, Dr. Johnstone Stoney, had given a lecture in Dublin which, if I remember aright, was connected with certain geological facts which he had observed in County Dublin. He chose a title suggested by certain beautiful lines of Longfellow.* He called it "A Glimpse through the Corridors of Time." Adopting this title—and I hope my old friend forgave me for the piracy—I announced as the opening lecture in the New Midland Institute Hall "A Glimpse through the Corridors of Time." But the subject that I was about to discuss was not the same as that with which Dr. Stoney dealt. I had what I think I may say was a far grander theme. It was a subject which is now pretty well known to those who are conversant with astronomical matters, but in 1881 it was by no means generally known. I was fairly confident that scarcely anyone in my large audience knew much about it. It existed only in scientific papers published by the Royal Society and elsewhere, and had not, so far as I know, been divested of its mathematical garb and presented in a form which made it intelligible to the general public.

On this occasion I did what I had not done before—I wrote out the lecture before it was delivered. In later years I often wrote out my lectures, but that was long after they had been given several times. Although I had written out "A Glimpse through the Corridors of Time," I am not at all sure that I read it. When lecturing to the public, it was my invariable practice to trust to memory for what I had to say. People who

* "The Day is Done," v. 5.

"Not from the grand old masters,
Not from the bards sublime,
Whose distant footsteps echo
Through corridors of time."

The use of this title for an astronomical lecture was apparently thought of on June 6th, 1879, when it is entered in his diary as "A grand subject."

do not know much about lecturing have often said: "How wonderful it is to be able to remember all you want to say for an hour and a half without ever looking at a note or a book." The reply to such an observation obviously is: "How can a lecturer expect an audience to remember his lecture if he is unable to recollect it himself?" My experience is that once the lecture has been put in order, and the lecturer has made up his mind as to what he wants to say, and how he will subdivide it, memory serves one as a matter of course.

My manuscript of the "Glimpse through the Corridors of Time" passed into the hands of the Press. It was printed *in extenso* in *Nature*,* and was quoted from and commented upon far and wide.† Let me set forth in brief what the subject was, because it has no inconsiderable relation to subsequent matters in my reminiscences.

It had been known from early times—at any rate, since the days of Julius Cæsar—that the moon and the tides were connected. On the day of full moon the tide is high at London Bridge at a certain hour in the morning. A connection so obvious as this must have forced itself upon the attention of those whose livelihood was sought on the river, and to whom the question of the tides was one of daily importance. As the moon affects the earth by producing the tides, so there must be a reaction of the earth on the moon. I shall not attempt to go here into the history of this matter. That must be sought elsewhere. Suffice it to say that, subsequent to the labours of Kant, of Helmholtz, and of Purser, Professor Sir George Darwin, of Cambridge, the famous son of a famous father, undertook the investigation of this subject. He showed that the effect of the tides was twofold. He showed how the speed of the earth must be gradually diminishing, and he proved that the moon must be gradually getting farther away. Looking into the past, tracing with firm logic the conclusions to which mathematical theory must lead; disdaining to allow his imagination to be cowed by paltry centuries or thousands of years of historical time; nay, even disregarding the millions of years required for the geological phenomena of which the

* The lecture seems to have created quite a sensation in the office of that journal, for Mr. Keltie, the Editor, wrote on December 13th, 1881, "Allow me to congratulate you on the exhaustive success of your Tidal articles. The two Nos. were all sold long ago and are still abundantly inquired for."

† It was subsequently published in pamphlet form by Macmillan and Co. (1882).

crust of the earth gives evidence, he showed how, as we go back through the illimitable past, the earth was ever spinning more quickly and the moon was drawing ever closer and closer to the earth. He conjured up a vision of the time when the earth spun round in a few hours, and when the moon was quite close to it. Having arrived at this point, it was not difficult to imagine how the moon and the earth were originally one body, and that the rapid rotation of the earth was the cause of the detachment of the moon as a part of the original composite mass. Finally, he proved that during the intervening ages the tides have been gradually diminishing and gradually enlarging the orbit of the moon, until the moon, having cooled down from its original incandescence, became the object which, shining by reflected light, now illumines the heavens.

My address was well received both by the audience and by the general public. I would not, however, have it understood that all I stated in that lecture met with universal acceptance. It led to some considerable discussion, and even my valued friend, the late Sir George Darwin himself, did not quite accept my views.

Professor George M. Minchin wrote with reference to the lecture on "Time and Tide":

"I cannot refrain from calling your Birmingham lecture a singularly beautiful and instructive one. I read every word of it—a thing which, I really believe, I have never done with regard to any other lecture or paper published anywhere.

"The whole story is the most wonderful imaginable."

Amongst those who lectured in the new theatre of the Midland Institute in 1881 were my colleagues of Trinity College, Professors Atkinson and Mahaffy. Professor Sir W. F. Barrett also lectured that year.

It certainly is not an exaggeration to say that during my lecture rambles I was most hospitably and most kindly entertained at hundreds of private houses. I have kept all the letters relating to my lecture travels, but I am sorry to say that I seldom kept a diary. It was only on rare occasions that I set down any particulars likely to be of use to me in compiling reminiscences. I give for what it is worth an entry in my diary of January 7th, 1890:

"Goole. Audience of 1,000, many turned away. A nice little chapel. Met here Sutcliffe, an old College of Science man, who got a Whitworth Scholarship, went to Bristol, and then was appointed to the docks here. . . . Goole is an interesting place—young and thriving as an American city. The coal is brought down in iron barges, each with thirty-five tons. These are linked together like a snake for draft down the canals. Each train has fifteen drawn by a tug. Each barge is then hoisted bodily out of the water on a cradle and tipped into the ship. Of course, this is adapted for water carriage, but the Cardiff system of dealing with smaller weights (eight tons) seems to me preferable. The lecture on 'Other Worlds' did well, but there was a mob of noisy school children in one part of the room. It would be well to issue some general order about either not admitting children, or at all events not allowing them to sit together. The chairman announced to-night that at the future lecture no children under fourteen would be admitted. I adhered to my box of slides and found them do well. The prologue on Herschel was prefaced by a little narrative of my difficulty in getting in. How I met a man coming away who told me that dozens had been turned away, and that it was no use for me to try to get in. How I went to the side door and pushed through the crowd and was asked for my penny, and how when I said I was the lecturer, the doorkeeper exclaimed: 'Go on, I have heard that story before!' Then I put in a little general talk about worlds before starting with Herschel. This is really a good plan. It is never well to commence with a piece that requires connected attention. The two interludes for 'Other Worlds' were, first, the days of the week, and second, the discovery of Neptune and the star distances. By rights I should have given the spinning illustration, but as Goole is not a textile place, and as the chairman is the manager of the Lancashire and Yorkshire Railway, I thought the railway, with a graceful allusion to the chair, would be the most effective, and so it was."

On one occasion I was on tour with two lectures entitled "The Moon" and "Krakatoa: The Mighty Volcano." Having, as I thought, given the last lecture of the series on "Krakatoa," I lent my box of slides to a friend. On arriving at Leeds late one afternoon, what was my horror to find the town placarded with the announcement that I was to lecture that evening on "Krakatoa"! The only slides I had were those which were intended to illustrate "The Moon," and, with the exception of one or two, they were wholly inappropriate to the subject upon which I was "billed" to lecture. I offered

the secretary of the institution three alternatives: (i.) To lecture on the moon and call it so; (ii.) to lecture on the moon and call it Krakatoa; and (iii.) to lecture on Krakatoa, and illustrate it as far as possible with the moon slides. The secretary chose (iii.), as he said the people expected to hear about the earthquake.

Determined to do the best I could, I proceeded to the hall to make things ready. I asked for a terrestrial globe. Shortly before the lecture was timed to begin, certain assistants were told off to haul a huge globe up a ladder from the basement to the platform. It had scarcely reached the top when it fell with a loud crash. It was brought up again in two halves. I took the opportunity of saying at the commencement of my lecture that the globe with which I had been supplied was eminently suited to illustrate a lecture on volcanoes, because it had manifestly suffered from the effects of an earthquake itself. This seemed to please the audience. With the aid of the globe, a blackboard and some of the moon slides I managed to worry through. Indeed, I may say that the lecture was most successful.

I told them that as everyone within 1,000 miles of Krakatoa had been killed, either by the earthquake or the tidal wave which was caused by the mighty explosion, it was obvious they could not have photographs of what had occurred, but I would show them some slides which indicated that similar catastrophes had taken place in the moon.

Alas! for the treachery of memory. Sometimes in looking over my letters I read the names of places visited, of secretaries with whom I have corresponded, of hosts who have overwhelmed me with attention, but all have been forgotten.* Should any of my innumerable hosts and hostesses ever see these lines, will they kindly understand that I shall retain to the end of my life the most grateful and pleasant recollections of their unstinted hospitality, although, as I have just confessed, the details have faded from my memory? I have often been filled with confusion by meeting someone who said, after shaking my hand, "I'm afraid you don't remember me, but

* Amongst his papers I found a list of some of the persons whose hospitality he had enjoyed. It includes Mr. Alex. R. Binnie (Bradford); Mr. Lawson Tait (Birmingham); the Marquis of Ripon; Dr. Gott; Colonel Schwabe; Mr. G. B. Rothera; "Davis the Palæontologist"; and "the man who met me under Niagara Falls."

you stayed with us at so-and-so when you came there to lecture." Perhaps he would add: "Don't you remember Mr. A. or Mrs. B., whom you met? And don't you remember how you told this, or told that?" Although I am quite sure everything he said was perfectly true, I had often forgotten the whole thing.

When I think of my forgetfulness, it is some consolation to know that other men in other walks of life, although they may retain a memory of things which are a little out of the ordinary, sometimes fail to recollect incidents in the legitimate course of their daily work, even when that work is performed in the very best manner. Let me illustrate this with an example. In one of my lecture rambles I was staying at an important provincial town. The day was wet, but I ventured out in spite of the rain. Strolling along the street, I passed the court-house. Noticing some stir about the door, I thought I would take refuge from the rain and see what was going on. I entered the court just after the midday adjournment. I heard the usher calling for silence, and saw the judge reappear. I was greatly interested in the scene, because the judge, one of the most distinguished ornaments of the Bench, was an old college friend of mine. The prisoner, against whom things appeared to be going rather badly, elected to give evidence on his own behalf. There was the stamp of truthfulness about the man, and it was obvious to me that the jury were much impressed by what he said. Counsel having addressed the jury, the judge summed up at some length, and the jury acquitted the prisoner without leaving the box. It seemed obvious to my casual observation that in this instance the ends of justice were distinctly furthered by allowing the prisoner to give sworn testimony on his own behalf. Some years later, the same eminent judge wrote a letter to the *Times* in which he expressed the view that prisoners should not be examined on oath. Happening to meet him about that time, I told him that I had read the letter, and that I could not help contrasting what he said in the letter with what I had actually observed in the trial referred to. He at once said to me: "I'm sure you are perfectly right in everything you say about the trial, but I haven't the slightest recollection of a single incident connected with it." He then told me that such a failure to recollect was not unusual in his profession, and that, notwithstanding the intimate knowledge

of all the facts which an acute judge may possess at the time of a trial, yet the moment the case is over those facts are displaced by others. He went on to say that although in the trial which I saw, substantial justice might have been attained by allowing the prisoner to be examined, yet there were many cases in which it might be necessary, if the proper questions were not asked by counsel, for the judge to interrogate the prisoner himself. In his view this placed the judge in a position which he should not occupy with regard to the prisoner.

Ever since my days as Professor of Mechanics at the Royal College of Science I have taken a great interest in machinery and in manufacturing processes. Indeed, I think nothing is more interesting when on tour than to obtain access to great factories and be shown the processes which have brought wealth and renown to the district. Ordinary visitors may perhaps find some difficulty in seeing through manufactories. There are many reasons for this; a visitor makes demands upon the time of the owner, or of some responsible person. Again, visitors must take off the attention of the employees. Then there is another reason, not now deemed of such moment as it once was. The manufacturer may not like his works to be seen by anyone who may possibly be engaged in the same business as himself, and obtain hints for his private benefit. As a Gilchrist Lecturer, however, I could never for a moment be thought of as a possible competitor in business. It frequently happened that my host was a great manufacturer, and of course, in his anxiety to do everything to make my visit pleasant, when he found that I should like to see his works, everything was placed at my disposal. Once or twice when my host heard me express a wish to see some special industry, he has told me that it was impossible, as no one was ever admitted, the secrets being jealously guarded. However, I never found any disposition to refuse me when I made application to the place itself. Quite the reverse. Indeed, I remember one occasion on which the manufacturer with whom I was staying said he had often wished to see the works of a friend of his, another manufacturer in the same town, but had never ventured to ask for permission, and had never been invited. But when I asked for leave the friend said: "Oh, yes, come by all means; and bring your host with you." Go we did, and a very pleasant morning we spent there. The business

I refer to was exceedingly interesting. It was the manufacture of plate glass, and as plate glass is not made in many places the curious reader may possibly discover the name of the town to which I refer.

I have often been in the colliery districts, in South Wales, in the North of England, the Midlands and Scotland. On several occasions I have gone down a mine. I remember once visiting a coal-pit where I was told I had unfortunately come a day too late. On the day before the directors had given a great banquet, not in their offices or in the town hall, but in the depths of the mine itself, to which the guests had all been lowered. The foreman who gave me this information was careful to impress on me that it was a "hot" dinner, though I could not help saying: "Why shouldn't it be hot, for surely there was no lack of fuel!"

The manager who took me down this pit told me of a remarkable incident that occurred there a short time before. He vouched himself for the truth of the story; and I set it down substantially as he told it to me.

Everyone knows that coal is brought to the surface in a cage. The cage is raised by a wire rope which passes over a sheaf to the winding engine. This engine is in charge of a reliable man. When he receives a signal that the trucks of coal have been duly placed in the cage, he starts the engine and hauls the cage up to the top. The greatest caution is necessary to stop the engine at the right moment, for if the cage is hauled up too far there is grave risk of an accident. "Over-winding" used to be a fertile source of danger, though I believe there are automatic contrivances which have since diminished the risks. Men are also hauled up from the pit in a cage, but the speed at which they travel is very much less than that at which coal is raised. The speed at which coal is raised must be considerable, because otherwise a due amount of coal could not be lifted in the course of the working day, especially if the mine is anything like half a mile deep. The rapid journey upwards which would not hurt the coal would not be suitable for human beings; and when visitors are in the cage great care is taken lest they experience undue discomfort, or have any cause for alarm. I need hardly say that this is especially the case when ladies are included in the party. This brings me to the story told by the manager. He said that some time before

he had taken a party of visitors, including a lady, down the pit. They had seen the workings, and had arrived at the foot of the shaft for the ascent. The lady had not enjoyed the descent very much, and was decidedly uncomfortable about the return journey. The manager, however, had assured her that the driver of the winding engine was the most careful and reliable workman he had ever known, and that there was not the least ground for uneasiness. The cage was started on its quarter-mile ascent, and at first moved quite slowly; then all of a sudden it began to fly upwards at a most appalling speed. The passengers were shaken from one side to the other. The lady screamed with terror. Even the manager was alarmed. Just as they were arriving at bank the cage slowed down and stopped at the right place. Terribly shaken, but quite unhurt, the party stepped out. The manager rushed at once to the engine-room to administer a well-deserved reproof, and there, to his horror, found the engine-man lying dead upon the ground! Not till the Day of Judgment will the secret of that engine-room be known; but the manager himself believed, and all the people in the colliery believed, the explanation to be this: subsequent examination showed that the man had died of heart disease. The theory is that, while he was winding the cage at the proper speed he felt the hand of death upon him. He reasoned in this way: "If I drop dead, nothing will prevent over-winding and the probable loss of all these lives. I may live a few seconds. My only chance is to wind the cage up at the maximum speed, and perhaps by so doing I may live long enough to bring it safely to bank. He did bring it safely to bank, and dropped dead before the manager could reach the engine-room. Such is the story of the winder who was truly "faithful unto death."

II.—*Lectures at the Royal Institution*

In November, 1880, after I had had some considerable experience in the investigation of star-distances at Dunsink, I suggested to Mr. Warren De la Rue, who was at that time secretary of the Royal Institution, in Albemarle Street, that I should give one of the Friday evening lectures. It is well known that the Royal Institution has varied fields of activity. It was under its auspices that Davy and Faraday made their memorable discoveries, and in more recent years the splendid

traditions of the Institution, of which every Englishman is so proud, have been maintained by the discoveries of Lord Rayleigh and Professor Dewar. Only recently Professor Sir J. J. Thomson has succeeded to the professorial chair, rendered so famous by the labours of his predecessors. But the Institution does much else besides encourage research. Various courses of lectures are provided under its auspices. Some may be described as systematic instruction in an advanced branch of learning of which the lecturer is a leading exponent. There are also what are known as "Friday Evening Lectures." On these evenings during the season the lecture theatre is thronged, not only with leading men of science, but with various eminent persons not usually seen at scientific gatherings. A lecture is delivered either on a discovery which is attracting particular attention at the moment, or on some matter of antiquarian interest. Literary and artistic subjects are sometimes dealt with. Indeed, I do not know that there is any restriction whatever, provided the essential condition is fulfilled that the lecturer is one who is able to speak with authority. To take one of the most conspicuous and splendid examples, it was at the Friday evening lectures that Faraday explained to a delighted audience the results of his superb investigations in magneto-electricity—discoveries which have revolutionised the world. Visitors to the Institution are reminded of him by the statue at the foot of the staircase. He holds in his hand a representation of a coil of wire. It was with such a coil that he demonstrated that, on suddenly thrusting a magnet in or pulling a magnet out, an electric current was produced. This current, it is true, is only instantaneous, but with the eye of genius Faraday foresaw what that phenomenon might lead to. To enumerate the men who have given Friday evening discourses at the Royal Institution would be to mention all the most distinguished men of learning, past and present, who have been called into being since the days when these lectures were first started. So far as my recollection goes, I do not think that Darwin was ever induced to lecture there. Doubtless ill-health required him to abstain from work that a more robust man might have been able to undertake. These lectures are not exactly open to the public. They are restricted to members of the Institution and their friends, and they are generally followed by an informal conversazione.

Lectures on Astronomy

It is a time-honoured tradition that the lecture is to commence precisely on the stroke of one hour and to terminate as punctually as possible on the stroke of the next. Everyone who has ever lectured at the Royal Institution will remember the lecturer's little room up one flight of stairs. Many anxious moments must have been passed in that room, for it is there that many of the men whom Great Britain most delighted to honour must often have waited in an agony of suspense. If the subject is one of general interest, the theatre is crowded long before the scheduled time. A few seats are reserved in front for members specially invited; but if these are not occupied within ten minutes before nine they are open to anyone, and the rush from the upper seats generally conveys to the lecturer, quaking in his room, that the fateful moment is only ten minutes distant! A minute before the hour he must be ready. When the clock strikes, an attendant opens the door, and the lecturer, greeted with applause, advances to the table on which so many historic experiments have been performed. It is (or used to be) a tradition at the Royal Institution that the lecturer shall introduce as many illustrations as he possibly can. In former days the "illustrations" generally took the form of diagrams, and experiments produced by apparatus on the table. The magic lantern was subsequently used for throwing pictures on the screen; and with the development of photography, and the constant increase in the excellence of lantern slides, this form of illustration has become of the utmost importance.

I used to think that to be allowed to give one of the Friday evening lectures at the Royal Institution was to receive the blue ribbon of the lecturer. I had frequently heard some of Professor Tyndall's lectures in that theatre—lectures which have been subsequently published in his works. Tyndall, the pupil of Bunsen, had a special genius for work of this description. On one occasion the great Clerk Maxwell, when about to give a lecture on some subject, wrote to a friend saying that he had been "Tyndallising" his imagination up to the point of being able to devise picturesque phraseology and to accompany it with effective experiments.

I took great pains with the lecture which was to be delivered in such a place and before such an audience. I believe I may say it succeeded very well—at least, I heard no com-

plaints. It was entitled "The Distances of the Stars," and was given on February 11th, 1881.

* * * * *

Thus far my father's own account of himself as a lecturer.

Mr. Coulson Kernahan has kindly supplied me with the following notes of a meeting with Sir Robert at the London Institution:

"It was in November, 1900, I first met Sir Robert at the London Institution. Mr. Frazer had a committee meeting, and so left us to ourselves for a long time. Sir Robert said that the greatest living man was undoubtedly Lord Kelvin. He also remarked that 'Kelvin never reads; he may now and then look at a number of *Nature*, but he positively never reads. Hence, when some book is brought to him by someone who urges him to read it, he has no standard of comparison, and indulges in superlatives.' I asked whether Kelvin were a greater or less man for not reading, and Sir Robert said 'greater.' He then told me that next to Kelvin came Lord Rayleigh, who was undoubtedly the second greatest living intellect."

"I gave Sir Robert tea, and I remember Frazer's servant coming to ask whether we wanted anything. He thanked her in the true Irish way, and said she had looked after us admirably, and that he should tell Mr. Frazer so. I said he was a true Irishman, speaking as prettily as he did to a mere maid, and that few Englishmen would do so. 'He would have thanked her civilly, but not in that sunny way of yours, Sir Robert.'

"'They're afraid to do so,' he replied. 'They are afraid someone will say that they are joking with a maid. We Irishmen, on the other hand, are afraid to make the most of ourselves. We are afraid to do what we might do.'

"'Isn't that a good thing,' I asked, 'if it comes of diffidence?'

"'But it doesn't come of diffidence,' he explained. 'It comes of something purely Irish, and is one of the reasons why we Irish don't do better for ourselves in the world.'

"We talked of Shan Bullock, and he asked if he was like Jane Barlow, whom Sir Robert had read. I said, 'Shan had more humour.'

"Sir Robert admires Jane Barlow's 'Irish Idylls.'

"Next we spoke of lecturing, and I said I was making my first appearance that year at the London Institution. He was, or kindly affected to be, immensely interested, and gave me much valuable advice. He asked me to let him know when my lecture was to be given, and said he would make a special effort to come to hear it. I promised, but with no intention of keeping the promise, for I knew he was a busy, if an intensely generous and kind-hearted man.

"When I met him long after my lecture had been given, he reproached me for not letting him know. He said he had read about it and was very much interested, and asked me to send it to him so that he could read it. Again I promised, but with no intention of keeping the promise, for I felt it was a shame to impose on his great-hearted Irish nature by bothering him with my twopenny-halfpenny lectures. He told me of the tons of letters he gets, some of them from the folk who believe the earth is flat, and said he didn't answer such letters, but had a big box in which he put them, calling it the 'Paradox Box.' Then he spoke kindly of Canon Shuttleworth, whom I know. He also spoke of a book by De Morgan, 'A Budget of Paradoxes,' which he said was hard to get; and said if a new De Morgan turned up, these letters (in the Paradox Box) would be of use to him."

III.—*The Children's Lectures*

My father relates how he came to deliver lectures to juvenile audiences:

I have described the commencement of my connection with the Royal Institution. The first *course* of lectures I was invited to give requires a little preliminary explanation.

It was, I believe, Faraday himself who first suggested the "Christmas lectures." He proposed that they should be for young people, not for learned men of science, or even educated adults. Faraday himself gave a famous course on "The Chemistry of a Candle," and many people will be familiar with the beautiful little volume in which he made his subject accessible to the world at large. He began by showing what candles were and how they were made. He would then produce a collection of candles great and small, candles coloured and candles white. He then proceeded to explain the functions of the wick, and by ingenious processes to illustrate the trans-

formation of the wax of the candle into inflammable gases. By means of little tubes he drew off these gases, both to show what they were and to explain the chemical reactions which took place. His knowledge of chemistry was such that, so far from finding it difficult to talk for an hour, it was all he could do to compress his observations so as not to exceed the allotted time.

To hear him must have been delightful, because there is a chorus of testimony that his powers were exceptional. Not, indeed, that he found lecturing an easy task. On the contrary, I have always heard that to prepare a lecture was for him a matter of excessive labour, while its delivery was preceded by a period of intense mental anxiety. Faraday very properly assumed that one who lectures at Christmastide to a juvenile audience is entitled to more latitude than if he were addressing a Friday evening audience at the Institution.

Many other distinguished men succeeded Faraday. Professor Tyndall gave the lectures on many occasions, with the happiest results. Professor Sir James Dewar has also undertaken the task. On one occasion he treated of meteorites; and greatly delighted one of his audience—a small child of my acquaintance—by a distribution which he made. He gave to each of the young people present a glass tube containing a fragment of a veritable meteorite. They were thus able to bear home little particles which had come from the remote depths of space.

It was when I was Astronomer Royal of Ireland that I received an invitation from Mr. De la Rue to give the Christmas lectures. I accepted the invitation, but not without grave misgivings. I felt that I must emulate the great men who had preceded me, and do something worthy of the Royal Institution. It was for me to interest children and young people in astronomy, a subject which did not appear to admit of experimental demonstrations similar to those which the Christmas audience had been long accustomed to expect. Having undertaken the task, I worked hard to obtain a sufficient number of illustrations. My old friend Mr. Vincent used to say that Faraday had a rule that there should be one experiment every two minutes during the Christmas lectures. This was rather an exacting ideal. However, I did the best I could. It was a simple matter to get certain kinds of slides. I could obtain pictures of observatories, instruments, sunspots and lunar

craters. Pictures of Jupiter, Venus, Mars, and of nebulæ were also available, but at that time the dry plate had not taken its place in the astronomical observatory for the purpose of obtaining pictorial representations. Dr. Isaac Roberts had not commenced his astronomical career. His wondrous picture of the great Nebula in Andromeda, which I often showed in later years at the Institution, was not in existence. Although the foundations of the Lick Observatory had been laid at that time, fifteen years or more would have had to elapse before Professor Keeler's pictures, obtained under the most perfect conditions, were to reveal the wonders of the heavens. I could obtain no photographs of star-clusters similar to those taken by Professor Pickering, on some of which twenty thousand stars have been shown, nor pictures like those produced by Professor Barnard at Yerkes Observatory, in which the delicate wisps of the Milky Way are so beautifully shown. I had none of these adventitious aids to illustrate my first course of lectures at the Royal Institution. But I had invaluable help from everybody connected with the Institution. For the fortnight during which the lectures lasted, I spent the greater part of each day in devising contrivances which would explain what I had to say. To procure large wooden models representing the instruments used in an observatory was comparatively easy, but I soon discovered that people do not greatly care to hear about the instruments in the observatory; what they do greatly care to hear is whatever you can tell them about the heavenly bodies, their sizes and distances. As to means and methods of observing, they are generally willing to take the word of the lecturer, and if on rare occasions scepticism does manifest itself, it is my experience that no illustrations of the methods by which the observations were made will suffice to allay the doubts of the sceptic.

At the time of which I write—December, 1881—Professor Tyndall was in residence in the rooms at the Royal Institution which had formerly been occupied by Faraday. Nothing could exceed his kindness and readiness to help. He placed the resources of his laboratory, and practically the resources of London, at my disposal. I had only to say what I wanted—a celestial globe, the materials for red or green fire, a consignment of modelling clay, some gun-cotton. Whatever I asked for was duly provided.

Having regard to the ages of my audience, I thought I could not begin with matters which were too elementary. I proceeded to show how the moon was lit up by the sun. Having procured a large indiarubber ball, I suspended it by a string. A beam of electric light would illuminate half the ball. Its brilliant side being differently exposed to persons in various parts of the room, the phases of the moon were seen and understood. To illustrate the appearance of lunar craters, I fashioned a round, rugged ring of modelling clay on a drawing-board. In the centre of the ring I placed a miniature "Matterhorn," and mounted the whole on a sheet of white paper. When we turned a beam of light from the lantern full upon this model, the mountain range forming the ring and the mountain peak in the centre cast shadows similar to those on the surface of the moon. I had a model of Saturn with his rings; an arrangement to illustrate an eclipse, a comet which gradually extended a splendid tail and then disappeared, a nebulous-looking object which, when shown on the screen, was made to transform into a cluster of stars; and smoke rings which were shown in illustration of the annular nebulæ. The colours of the rainbow led up to some slight explanation of how we ascertain the nature of the very substances of which the heavenly bodies are made. A Foucault's pendulum—that is to say, a large ball swung from the roof—enabled me to show that the earth was turning round on its axis. It was thus that the first lecture went through. There was a crowded house each day, and I believe I may say the lectures were well appreciated. I know I greatly enjoyed their delivery. One of the most interesting circumstances connected with a lecture at the Royal Institution is the friendly talk which always follows at the lecture-table. Some of the audience come to shake hands and exchange a few words with the lecturer. Many interesting people thus make themselves known. At the Christmas lectures, in particular, many young people would timidly approach to have a closer look at something on the table, or to ask a question. Half an hour was pleasantly spent this way after the lecture was formally closed. This miniature levee downstairs was generally followed by another upstairs in the lecturer's room.

It was several years after my first course of Christmas lectures at the Royal Institution that I was asked to give a

second. The genial Sir Frederick Bramwell was at this time secretary, and to his courteous invitation, which reached me in June, 1891, I replied that in the former course I had given a set of six lectures on the sun, moon and stars, and the sun, moon, stars, etc., were still just the same as they were on the former occasion! In his reply he admitted that the heavenly bodies had undergone no change; but he pointed out that an entirely new generation of boys and girls had since sprung up, and that, even though the lectures did traverse much of the same ground, yet that they would be new to this second crop of young hearers. This argument was unanswerable, and a second course of lectures was given. Some of the illustrations, I have no doubt, were the same, but they were added to, and I hope improved upon. The attendance was large, though possibly not larger than formerly. Once or twice since I have given these courses of Christmas lectures. And here I would point out that of the eight hundred people or so who thronged the theatre on these occasions all were not juveniles. To describe the lectures as "Lectures to Children" is by no means correct. Perhaps a fourth of the whole number was what might be called young people; possibly a certain fraction of these might be described as "children," though I do not exactly know at what age the term "child" ceases to be applicable at the Royal Institution. But the audience was always very interesting. Composed as it was of people possessing an almost infinite variety of intellectual attainment it was calculated to put the lecturer in a position of some difficulty. Perhaps the best plan to adopt is to commence the first lecture as a friend of mine once did. He said: "The lecture is addressed to children. I observe that a great number of elderly relatives and a large number of adults who have no children to look after are also present. Well, children, you and I will not mind all these grown ups if they will only behave themselves properly!" He thus established himself on quite a satisfactory footing with his class.

It is almost impossible to give statistics of the people who were present, but it may give some idea of the varied audience who honoured me by their presence if I say that at one lecture at the Institution I happen to know that there were present—a child of eight years old, Sir Squire and Lady Bancroft, Madame Albani, Madame Antoinette Sterling, the Presi-

dent of the British Association, and the Lord Chancellor. I received the following letter from Madame Albani (January 10th, 1893):

"I attended your Christmas Lectures at the Royal Institution lately, and I cannot help writing to tell you how much I enjoyed them, and to thank you for having given us such an intellectual treat. I was most interested (as were my boy and husband), throughout, quite as much as if the lectures had been on *music*, and was only too sorry when they were all over.

"I ventured to shake hands with you after the last lecture on Saturday, but my delight at the subject, and the way in which all was explained, must be my excuse for the liberty I took."

In circumstances like these, repeated with innumerable variations every day, a lecturer might well feel embarrassed. He would scarcely know what to say and what to leave unsaid. He had, however, this much to console him: that if he were taxed with the fact of having said things which were too easy, or too absurdly difficult, he could at once reply that it all depended on which part of the audience might at the moment be presumed to be listening to him.

On only one occasion during my lectures did anything in the nature of a mishap take place. This was many years ago. It was of a very trivial nature, but it might have been very much the reverse. The galleries of the Royal Institution have been altered, so that exit from them would now be quite easy in the event of any emergency. Before the alteration, alarmists were constantly writing to the papers. Once or twice letters appeared in the *Times* calling attention to the dreadful consequences which would ensue if there were a panic. One such letter had appeared on the morning of a day on which I was to lecture, the time of the lecture being, as usual, three o'clock in the afternoon. The matter was therefore somewhat on my nerves, especially when I saw that the room was crowded. A small spirit-lamp, which had been placed on the table for some experiment, was upset when a piece of apparatus was being moved. The burning spirit ran on the cloth, and an ineffectual attempt to blow it out made things rather worse. The lights being low at the moment, the flame of the burning spirit was visible everywhere, and it appeared to be extending. One or two people uttered slight exclamations; and I must say that I spent an exceedingly awkward half-minute, until some lady—

an unknown friend whom I never identified—stepping up behind me, threw her cloak over the fire and instantly put it out. The incident was mentioned in the papers next day, and it caused me no little distress. It is satisfactory to think that, with the means of egress now provided, there is no cause for any further uneasiness. The effect on the next lecture was, however, a bigger audience than ever! The poor assistant, as I heard afterwards, got a terrible wigging from the authorities. I intervened at once to point out that it was I and not he who upset the lamp. But the real cause of trouble was having that common, foolish, and dangerous sort of spirit-lamp there at all. It was entirely contrary to the rules to allow such a thing in the place, and Professor Dewar said he did not even know how it got there.

Though I think I may say the Christmas lectures were always very well attended, the theatre being usually crowded long before the time of the lecture, I don't think any of them had quite the "go" of that first course.

I remember once being at a lecture there by Professor Abel. He had a very innocent-looking cylinder on the table, with a cock in it of a particular construction, and he told us that the cylinder was full not, indeed, of gunpowder, but of exploded gunpowder, and that he was relying on the strength of the cylinder to keep in the tremendous pressure of gases inside. He drew off these gases from time to time through the cock to analyse them for our instruction, and a most interesting lecture came to a close without anything happening to alarm anyone. One of the ladies present, however, told me afterwards that she was engaged mentally during the lecture in thinking at what part of the roof it would be that she would make her exit when the explosion came, as come it would she most firmly believed!

* * * * *

Some account of what my father said in one of his Christmas lectures is to be found in a letter to Mr. T. Hanson Lewis (June 5th, 1901):

"I rather drew them at one of my Christmas lectures by asking what message they wanted to signal to Mars, and I said it would be quite possible to guess the signal that they would send to us. To an assembled conclave of expectant listeners the first message to arrive would certainly be 'Are you there?' It

would be possible to signal to Mars if you could wave a flag the size of Ireland, or, as I have suggested more recently, if Lake Superior were covered with petroleum and set on fire, it would be visible to those who had good telescopes on Mars."

Sir Charles Ball has supplied me with the following account of the origin of "Starland":

"Shortly before he delivered the Christmas lectures in 1887, which were—in the main—a repetition of those delivered in 1881, a well-known publisher called on Sir Robert and asked permission to send a reporter to take down the lectures *verbatim,* with a view to their publication in book form. He said he would leave it to the lecturer to name his own terms for this privilege. My brother demurred, saying that he sometimes said things in his lectures which he would not desire to see in a book.

"'These,' said the publisher, 'are precisely what we want to catch!'" The shorthand note was taken and transcribed. Largely re-written, it formed the basis of 'Starland.'"

Some time after that book appeared (in 1889) my father prepared the following memorandum:

"I would like to put on record a word or two with regard to my little volume, 'Starland.' It has excited so much interest, and is having such a wide circulation, that its author may very well feel gratified at its success. The wish has been expressed that I should explain the origin of this book, and though I am naturally reluctant to enter into matters of a personal character, yet there are sufficient reasons why it is desirable to give an authentic account of the matter.

"I have frequently been requested to recommend some easy book that would be suitable for those who wish to learn about the stars. It was to be in simple language, so that young people should find it readable and interesting, and it was also to be inexpensive. People who did not wish to pay a pound for a work on astronomy told me they would be quite willing to give five or six shillings, provided the work would tell them and their children what they wanted to know in a sufficiently pleasing manner. I knew, of course, there were many admirable treatises on the science of astronomy in the market, to many of which, I ought to add, I am myself constantly indebted; but I often found great difficulty in selecting one which would combine all the wants expressed by my correspondents.

Some were too deep and difficult, and some were too dear; some were too large, while others did not make the subject sufficiently interesting. I therefore ventured to try and write a book myself which would supply the want so universally experienced. The volume 'Starland' was the result. How far it has succeeded it is hardly for me to say."

He sent a complimentary copy of "Starland" to Mr. Gladstone (who was then Prime Minister), and received the following reply (May 9th, 1889):

"I am greatly obliged by the gift of your volume which reached me last night, and I have already ascertained for myself that it is not less interesting than beautiful. I hope to profit much by it."

A little later Mr. Gladstone wrote again:

"I have now finished reading your luminous and delightful 'Starland,' and I am happy to be, in a sense, enrolled among your pupils; for although I have been fond of mathematical subjects in my day, I am now glad to have everything imparted to me in the form in which it makes a minimum demand upon a diminishing stock of brain power. I am enormously grateful for your notable and successful efforts to bring yourself down within reach of feeble or sluggish minds. The worst of the matter is, from your point of view, that I am too much impressed to leave off here with simple thanks, while I am afraid I must still postpone for a time the perusal of your larger works. But I am tempted to mention to you an address by M. Janssen to the French Academy (of which he is a member), which he was kind enough to give me last year, termed *L'Age des Étoiles*. It was to me extremely interesting, but of course I am no judge of its merits. It uses more largely than your lectures the aid of spectral analysis in relation to the ages of the heavenly bodies. If you would like to see the address I shall have great pleasure in sending it for your perusal, and if you thought it of value, I would endeavour to procure you a copy.

"When I first became Chancellor of the Exchequer, I found that the Bank of England and the Treasury used the letter 'M' as a convenient abbreviation for £100. For my own convenience I improved (as I thought) upon this by adopting 'M' with a tail—very easily written—for a million; and though financial demands rarely ran so high, I have gone a step further and thought of (M) as equal to MM, or the French milliard. It would be more scientific to make this symbol stand for MM; but it is an extravagance suited only to astronomical distances.

It occurs to me that symbols of this kind (replacing £ by miles) might be of some use perhaps in writing such distances.

"Your books bring other subjects to my mind, and make me think that the teachers of the uniformity of Nature sometimes press rather hard upon us the common herd. If our moon does not revolve upon its own axis, if the moons of Uranus (I wish it had been Ouranos) describe circular orbits, and those of Mars travel eastwards, a very elastic definition of this uniformity seems needed to cover such varieties.

"Pray do not take the trouble to notice any of these stray remarks, unless you would like to see M. Janssen.

"W. E. GLADSTONE."

The Archbishop of Canterbury (Dr. Benson) also received a copy. His letter of thanks (dated December 30th, 1889) contained the following passage:

"Knowledge, even a little, of the stars always seems to me to *stretch* the ideas of young folks in the healthiest and grandest way. I thank you for believing that I should care to see this beautiful book which will, I am sure, have this effect; it is my next present to a boy."

I do not propose to give particulars of the various editions, but about nine years after the first edition appeared Sir Robert wrote to Dr. Rambaut (December 30th, 1898):

"I have an urgent letter from the Editor of Cassell's to say that they have 'quite run out of "Starland."' Whether they were hunted out by the Bull or whether it was the charms of Virgo, or from what other cause they had to make the run, does not appear, but the moral is that they must go to press forthwith, and that they don't want too many changes."

IV.—*The Gilchrist Lectures*

For many years I lectured for what is known as the Gilchrist Trust. It may be interesting to give a short history of this Trust, and to explain its functions.

It appears that many years ago a sum of money was bequeathed by a Mr. Gilchrist to trustees, the interest to be employed in any manner the Trust deemed advisable for the diffusion of knowledge. Mr. Gilchrist had himself a somewhat remarkable career. He at first wrote books for the assistance of students who were learning the Indian languages. He subsequently founded a bank. At the time of his death, however—and, indeed, for many years afterwards—the funds which came

to the hands of the trustees were comparatively insignificant. But one or two portions of his property which were at first thought to be of no great moment, underwent a phenomenal development. For instance, in the course of his banking operations it appears that someone became indebted to him in the amount of £17 10s. The debtor, not being able to discharge his liability in cash, offered to Gilchrist, in lieu of the debt, some property which he had in Australia. This consisted of a strip of land fronting on Sydney Harbour, which must apparently at that time have been deemed to be of little value. Indeed, for a long time it was absolutely unproductive. After Gilchrist's death the trustees came into the possession of this land as part of his property. They were warned that unless they went to the expense of putting a fence around the property it would suffer from encroachment. I have been told that they regarded the expenditure as probably quite unproductive; indeed, they would not have entertained the question of the fence, had they not been advised that it was their duty as trustees to do everything necessary to keep the property together. The fence was accordingly put up, but many years elapsed before any result was derived from it. At length, when Sydney underwent great extension this property came to be required. The result was that a piece of real estate which had originally been purchased for £17 10s. brought in no less than £70,000 to the Gilchrist Trust! The bank which Gilchrist founded also prospered, and was, I believe, the nucleus of the Commercial Bank of Scotland. Eventually the trustees found themselves in possession of an income of some three or four thousand a year. Part of this money was devoted to scholarships, and, as was quite seemly in the circumstances, some of the funds so allocated were expended in Australia. But my concern at present is with that part of the business of the Gilchrist trustees, which undertook the providing of lectures to be delivered in various towns in Great Britain.

From the first it was the policy of the trustees to send their lecturers to small places rather than to great centres of population, where it might be presumed local resources would provide lecturers. I do not for a moment say that the Gilchrist lecturers did not often go to large towns; I myself frequently lectured in London for this Trust. Generally speaking, however, we were asked to lecture in small towns

in the manufacturing districts of Lancashire and Yorkshire. As soon as the work of the Trust became known, and the lectures in one town had been heard of by residents in the neighbourhood, a considerable demand sprang up, and the Trust received innumerable applications. The arrangements, speaking generally, were something like this: A committee had to be formed in the town to guarantee the provision of a hall and a lantern —if a lantern were required. The committee also undertook the advertisement and management of the lectures. The secretary of the Trust then visited the town to inspect the lecture hall. The conditions with regard to the hall were modified according to circumstances. It was generally stipulated that the hall should be large enough to provide 800 seats. If it were large enough to hold more, the committee was able to treat the excess as reserved seats, and make what charge they pleased for them. It was, however, imperative that the reserved seats should not be put in the best parts of the hall, to the exclusion of the penny seats, which were specially intended for the working classes. The proceeds were paid to the local committee, and it not infrequently happened that they derived some profits from the course, which were generally applied to providing similar lectures on subsequent occasions. All their conditions being complied with, the trust undertook to defray all expenses connected with the lecturer. The late Mr. Richard A. Proctor—a well-known writer on astronomy—was a very popular Gilchrist lecturer. I heard him two or three times in Dublin, where he came in response to the invitation of the Royal Dublin Society. He possessed considerable literary power, and his lectures, which were delivered in admirable language, were frequently adorned by apt poetical recitation.

My connection with the Gilchrist Trust came about as follows: I received a letter from my old friend, Dr. W. B. Carpenter, who was at that time secretary to the trust, in which he told me that Proctor was about to start on a lecturing tour of the world, which would involve his absence for two or three years. Dr. Carpenter asked me if I would undertake the Gilchrist lectures in Proctor's absence. I gladly accepted the invitation, and thus became connected with the Gilchrist Trust, a connection which remained unbroken for some twenty years. It is bound up in my memory with innumerable pleasant associations.

Lectures on Astronomy

Dr. Carpenter invited me to take a circuit. How well I recollect the towns in that circuit, and many of the circumstances connected with them! Indeed, I recall the incidents of my first Gilchrist lectures far better than I am able to recall many similar lectures of a much more recent date. The towns in the circuit were Rochdale, Accrington, Huddersfield, Preston and Bury. My first Gilchrist lecture was at Rochdale, on January 27th, 1880. The chairman was Mr. Petrie, the mayor of the town. He was also my host. I should mention here that when the Gilchrist trustees send their lecturer to a town, it is generally understood that some local magnate—by preference the chairman for the evening's lecture—is to act as host. Thus it almost always happened in my Gilchrist experiences that I was the guest of some interesting person. Occasionally I was forced to obtain accommodation at a hotel, but this was rare, and I always preferred going to a private house.

In the early days the local people were often in doubt as to whether the Gilchrist lectures would be sufficiently patronised by the working classes for whom they were intended. In illustration of this I may recall what happened at Blackburn. The day was deplorably wet, and the state of the weather, together with the result of the mayor's own inquïries, had led him to fear that there would be but a small attendance. It was my first visit to Blackburn, and the kindly mayor was very anxious that the lecture should be a success. He seemed to apprehend that I would feel that I had been treated with scant courtesy if there were not a full house. The rain got steadily worse in the afternoon, and when we started for the hall after dinner the mayor's prognostications became so gloomy that I endeavoured to cheer him up. But with no great success. Eventually, when we reached the vicinity of the hall and saw no crowds pouring in—saw no one, in fact, with the exception of a couple of policemen standing outside the door in the drenching rain—he became desperate and said: "I knew it would be so; the thing is a total failure!

"Is there anyone inside?" he called out to the policemen. The answer was: "We turned away two hundred half an hour ago, as the place was packed!" This was, indeed, the general experience of those who gave Gilchrist lectures; house packed and every inch of standing room occupied. I generally went

to the hall at least twenty minutes before the hour fixed for the lecture. On one occasion—I do not remember the time or place—the chairman, secretary, and lecturer were all in attendance twenty minutes before the appointed time. The place was crammed to the very door. "What is the use of waiting?" said the chairman. "Not a single human being can get in." We accordingly commenced the proceedings.

When the Gilchrist Trust first proposed to send lecturers up and down the country, there were some who thought it might be difficult to dispose of eight hundred seats at a penny each. Their doubts were dispelled when the reputation of the lectures began to spread. I never witnessed the distribution of the tickets; this always took place long before I arrived on the scene, but I have heard wonderful accounts of the crowding and crushing which attended their sale when the day of issue arrived. I have also been told fabulous stories of the amount at which the penny tickets would change hands as the time of the lecture approached. The reserved seats also, no matter what price was put upon them, generally sold very well. I had frequent applications from people who complained of being unable to procure tickets. Of course, this had nothing to do with me, though sometimes when the application was one that captured my fancy I have gone so far as to tell the secretary that the lecture would not begin until a particular person got a seat.

I do not wish it to be understood that the lectures were always well attended. That is not the case. I have sometimes —but, indeed, I must add very rarely—seen the hall half empty. I can recall two cases in which this occurred, and, strange to say, they were both in large places. It would seem that in the small towns the fact that there was to be a lecture became known to every man, woman, and child.

For many years a large proportion of the Gilchrist lectures were delivered in towns in Lancashire and Yorkshire. I have counted as many as two hundred places in these two counties where I had myself lectured for the Gilchrist Trust. Gilchrist lecturers were not often sent a second time to the same town; but this did happen sometimes, and I have known places where even three visits have been paid.*

* The following is a list of towns in which he lectured in 1890: Long Eaton, Leven, Whitehaven, Mossley, Greenock, Barrow, Eccleshill, St. Helens, Pontefract, Dumbarton, Glossop, Middleton, Coatbridge, Northwich.

Lectures on Astronomy

I here copy some notes from a diary of a Gilchrist tour:

"Yorkshire by some means manages to secure half the total number, leaving the other half for the rest of England, the whole of Scotland, Wales, Ireland, and the Channel Islands. The equity of this is not obvious. The other places say it is because Yorkshire wants enlightening so much. The Yorkshire people say it is because they are so capable of appreciating the lectures.

"Lady Ripon told me that Gladstone talks little or no politics at home. He is always full of the last book he has read. Just then it was the life of Dabney. Dabney was the planter and slave-owner who was a hero in prosperity, and when adversity came would not let his daughter touch the washtub, but did the washing himself. The old man felt so proud when he got the linen white! Lady Ripon said that Gladstone spoke of this book with such enthusiasm that the tears streamed down his cheeks. It was published by Dabney's daughter in America, and Gladstone wrote to ask her if he might get it published here, and begged her merely to say the word by wire, "Proceed," if she consented. She had done so. *Mem.* to get the book.

"At Chipping Norton it appears that my lecture was sufficiently popular to attract a very respectable fraction—one-eighth—of the population. It has 4,000 inhabitants. Mr. Donelly, the secretary, is the manager of a branch of Gillett's Bank there. Mr. Bliss, my host, is a good *raconteur*. His description of the origin of the Chipping Norton Tweed Mills (the only mill in the place), which he owns, was good. His great-grandfather travelled for *his* great-great-grandfather, a worsted manufacturer, in the West of England. While on his rounds he fell in love with the innkeeper's daughter at Chipping Norton. His father sent him back to break off so inappropriate a match. The old innkeeper offered to give the young couple money enough to start a woollen business in Chipping Norton; and so it began."

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V.—*His Methods as a Lecturer*

My father never used any notes when addressing an audience. By degrees, however, he reduced all his better-known lectures to writing. Of these there are two typewritten copies in existence; but they are prefaced by a desire that they should

not be published. He adhered more or less faithfully to what he had written down, but was always trying to improve.

On one occasion he was invited to address those who were interested in the University Extension Lecture movement. The following is a copy of some notes he compiled for the purpose:

"Always try to improve. No matter how often a lecture has been given, you should sit down the next morning—or, better still, the very same night—go over every point, and see how you can do it better next time. Don't imagine I always do this myself; but as Puddn'head Wilson says in his immortal Calendar: 'To be good is noble; to teach others to be good is nobler still, and less trouble.'

"The problem that confronts the lecturer is often a complex one. Here again, Mr. Chairman, I would have you excuse me if I talk about my own case. I lectured last winter at the Royal Institution. The lectures were supposed to be for a juvenile audience, and there were about two hundred juveniles each day. They were about one-fourth of the audience!

"I have often been asked: 'Do you not get weary lecturing night after night?' My reply was: 'Ask the good golfer if he gets weary hole after hole. Ask "W. G." if he gets weary century after century. When you have some skill in your art the exercise of it is delightful.'"

He took the greatest pains to have his slides as complete and as perfect as possible, sparing no expense. If the slides were to be exhibited by a local man who was not familiar with astronomical matters, my father would find time to give him some preliminary drill. He would say (*inter alia*): "There are eight ways of putting a slide into a lantern, seven of which are wrong!" He was always ready, however, to make allowances for inexperience and to forgive a fault. Writing to Dr. Rambaut on March 2nd, 1899, he said:

"Unless I warn him beforehand, the man at the lantern will probably make the moon go round the earth as if he were grinding coffee for a wager! However, when I feel inclined to abuse one of these poor chaps, I am reminded of the just retort of the Irish railway porter who, when expostulated with by some sensitive passenger on the diabolical accent, the vile intonation, and the utter unintelligibility of the way in which he bawled out 'Bootherstown,' said, 'You don't expect a primer donner at twenty-four shillings a week, do ye?' So if the lanternist were really competent to interpret the lecturer, the pence at one end

of the hall, and the pounds on the platform would have to be more equally distributed. Another terrible infirmity to which blundering lanternists are prone is to miss a slide out of its proper place. This is most confusing, and sometimes gives the lecturer away horribly. But it is nothing to the frightful disaster which occurs if the man, discovering his error a little later, shoves the slide in somewhere else. I had an awful experience of this lately which ruined the effect of a peroration!"

When my father gave his lecture "A Universe in Motion," which involved the use of a number of elaborate mechanical slides, he generally employed Mr. J. W. Garbutt, of whose skill at the lantern he always spoke in the warmest terms.

He always regarded lecturing as much more satisfactory than writing articles. In a letter to Dr. Rambaut on October 17th, 1897, he said:

"Lecturing is a more permanent source of income than writing, for the same lecture will be available scores of times, while there is (or ought to be) a limit to the number of times the same thing can be written. Then, too, lecturing is an amusing occupation, a rest and a change; but writing articles, even if dictated to a typewriter, I have ever found an awful grind."

His numerous platform engagements necessitated a vast amount of correspondence with which he dealt according to a system of his own devising. He had made to order a large number of books with brown paper leaves. Into these he would paste letters and papers of every description, not according to any regular classification, but, in spite of that, he always knew that any paper of importance was there, and that, aided by the index to each volume, it could be found after a brief search. When his engagements as a public lecturer began to increase, he adopted the plan of setting apart a particular page for each lecture. Everything, no matter how seemingly unimportant, would be crammed on to that page, each letter and document being fastened down by one corner, so that the letter beneath it could be read. Here are the contents of one such page: (*a*) A letter inviting him to lecture; (*b*) a copy of his reply stating his terms (and they were by no means *easy* terms); (*c*) the letter of acceptance; (*d*) a copy of his reply setting forth his requirements as to lantern, blackboard, etc.; (*e*) a copy of his letter to his assistant who managed the lantern; (*f*) a letter of invitation from some local magnate offering hospitality;

(*g*) his reply; (*h*) the printed circular or other announcement (not excluding, sometimes, a poster six feet square) relating to the lecture; (*i*) a page from Bradshaw having marked upon it the train by which he would travel; (*j*) a ticket for the lecture; (*k*) the letter which accompanied the cheque for the lecturer's fee; (*l*) a press-cutting of the lecture as delivered; (*m*) a copy of his letter returning thanks for hospitality; and (*n*) (frequently) one or more letters from members of the audience who had appreciated the lecture.

Members of his family used sometimes to poke fun at his "system," which led to the accumulation in his study of thirty or forty enormous volumes. He would counter the attack by the hoary old joke: "Did you ever hear how the firm of Messrs. Brown, Jones and Robinson made a large fortune in the City?" Without giving time for a reply, he would go on: "By minding their own business."

His daughter (now Mrs. Joseph Barcroft) acted for many years as his amanuensis. On one occasion, in her absence, a lady friend volunteered to do the work.

He wrote to my sister:

"Your fame as my secretary and the depth of distress to which it is supposed I am being reduced by your absence led —— —— to make a most sporting offer to take your place. I declined her kind offer.

"But it was very kind and thoughtful of her, and I really felt greatly obliged. The fact is that just at this time there are very few letters. I am off with the old love (the old lecture book) and not yet on with the new. I have, indeed, plenty of writing to do at this moment. But it is of this kind:

$$(AB - CD)(PX^2 + QY^2 + 2RXY) = O$$

for I am in the middle of my mathematical lectures. Indeed, just now I hear that I am to have a new class consisting of Mr. Berry, Mr. Richmond, and Mr. Whitehead. And I am to give them *nine lectures*. Is not that something to work for?"

In 1889 one of his colleagues in Trinity College, Dublin, who evidently aspired to success on the lecture platform, wrote to ask my father how he managed his lecture tours. He replied thus (May 14th, 1889):

"The plan I adopt is as follows. Formerly I used to make several visits in the winter to England, but last year, with great

advantage, I made only two trips, one occupying the greater part of November, the other a fortnight in January.

"The latter was managed entirely by the Gilchrist Trust, and all I do is to go to the towns that they indicate. They are generally very small places.

"The November trip I managed myself. I get many letters asking me to lecture here and there, and I reply naming the date that suits me. If it suits them, well and good. If not, I don't go. Thus next November I intend to begin in the north and work gradually downwards; that is, of course, assuming that I get the invitations that usually come in during the summer. I have, however, often had to make long journeys so as to utilise the time to the utmost.

"There are, I believe, agencies which profess to work lectures here as they do in America, and I know of a very respectable man—a Yankee, I believe—who is occasionally employed by Institutions to procure courses of lectures for them, and he has occasionally offered me engagements which I have accepted with satisfactory results, but I only deal with him (so far as time, etc., is concerned) just as I would with the secretary of the Institution he is acting for, were he to apply to me direct."

He once missed a lecture through no fault of his own. On the only route by which he could travel from Cambridge to Walsall the rails were washed away by a flood. His telegram announcing the calamity was read to the disappointed audience by the chairman, who aptly said that "the stars in their courses had fought against the astronomer."

Although in all his numerous journeys in many parts of England he never managed to get into a railway accident, he came very near it on one occasion. The incident is thus recorded in his diary:

"On Tuesday last, January 21st, 1890, a curious accident happened to the train in which I was travelling. The Huddersfield correspondent of the Central News thus describes it:

"'While the express train from Manchester to Leeds was travelling through (this is not correct; we had not reached the station) Marsden Station, the driver fancied something was wrong with his engine and pulled up. It was then discovered that the right centre driving-wheel had broken clean off from the axle, and it was actually found some 260 yards away, in a field. The engine had only recently been turned out new from Crewe, and was on the newest bogie principle.'"

Only once was my father compelled to disappoint an audi-

ence by illness. That was on February 7th, 1884, when he had to cancel a lecture owing to an attack of lumbago. He had at that date given over seven hundred lectures.

At an early period he sometimes lectured on Sundays, but latterly he made a strict rule to observe the Sabbath in this respect. In 1899 the president of a Sunday lecture society in the Midlands invited him to lecture to 3,500 people. In proffering the invitation the president said:

"Our success, increasing year by year, has been attained without our having had the advantage of a prosecution by the L.D.O. Society. I happen to know that they have sent spies to watch us. Knowing this, one opening night at the Grand Theatre I deliberately opened our coat-tail to its widest capacity, and ostentatiously trailed it; the only result was a letter in the papers saying that they were not going to trouble us. Independently of their not *daring* to do so, which makes us perfectly safe here, they would have no legal ground. We do not charge entrance; certain parts of the house are reserved for our members, but no money is taken at the doors; and the rest is free for as many as can get in. Of course, I am asking you to come professionally. If, as I trust, you can come, please let me know what your fee is."

Sir Robert wrote in reply:

"I have so many pleasant recollections of lectures in Birmingham that I greatly regret to have to refuse the invitation with which you have honoured me. It would indeed have been a great pleasure to me to have opened your course in the theatre.

"But several years ago I gave up Sunday lectures, and though I have had a good many invitations to renew them since, I have always declined."

He generally declined to lecture without fee, and the occasions upon which he did so were somewhat rare, at any rate in the early years. His reason is adumbrated in a letter written in 1880 to a lady who had asked him to lecture for nothing:

"I hardly know whether I quite understand the nature of the invitation to lecture at Weston. I certainly do often lecture in England, but then it is always on behalf of a certain married lady with five children who is solely dependent upon her husband for support. To speak plainly, I cannot afford the time to give lectures unless I am well paid for them."

In later years, however, he gave several lectures at Cambridge and elsewhere on behalf of the Missions to Seamen. This was partly due to the fact that his wife was for many years

treasurer of the Cambridge branch of that excellent institution. His last lecture in London was for the R.S.P.C.C.

He was generally introduced to his audience by a chairman. Having regard to his great popularity as a lecturer, this formality may appear to have been unnecessary. The reason why he never objected to being thus introduced stands revealed in a letter to a friend:

"I like chairmen; in fact, I doat on them; not quite so emphatically as Professor Blackie, who, when lecturing at Newcastle-on-Tyne in a theatre on Sunday night, was so delighted with himself and his audience that he declared he must kiss someone. Whereupon, amid a hurricane of applause and yells of delight, he hugged and kissed the unhappy chairman! But I won't kiss ——, I can tell you, not if I know it. Put his wife there and possibly—well, no, not even her!

"But I have other grounds for liking chairmen. First of all, there are always a number of intolerable people who come in late. They are generally the local swells, too, and all the people turn round to point them out and to see what they have on, etc. This I find most disconcerting, so to avoid it I always encourage the chairman to make a speech which shall be just long enough to last while these troublesome people are coming in. As soon as the disturbance in the hall settles down I give signs of disquiet which speedily cause the chairman to shut up. I often find it convenient, too, in the course of my lecture, to address the chairman personally, and if he happens to have put a new steeple on the church, or repaired the village pump, or presented a park, or made more mustard or soap than anyone else, I take care to get posted on the subject beforehand, and then introduce the little matter in some felicitous manner which makes things pleasant all round. Yes, I like chairmen, and am glad to have one.

"All right about the shooting stars. I like the subject, and will do my level best. I had upwards of 4,000 of an audience a few days ago."

When his repertory was complete he was indifferent as to which lecture he should give to any particular audience. In November, 1892, it had been arranged for him to lecture at K——, and he wrote from Cambridge:

"Did we settle the subject? I have no memorandum of what it is to be.

"I can congeal you with the 'Ice Age' or burst you up with the thunders of Krakatoa. I can tell you awful whoppers about 'Time and Tide,' or petrify you with a burst of eloquence about

'Invisible Stars.' I usually put the greatest rot into a lecture called 'Other Worlds'! There is a faint (very faint) *soupçon* of theology in 'An Evening with the Telescope.'"

Of his qualities as a lecturer it is unnecessary to speak. Suffice it that he achieved success—a success which was probably greater than any other popular exponent of astronomy. He was occasionally made the subject of curious comment. In alluding to his first Lowell Lecture, which was delivered at Boston, Mass., in 1884, the local paper said:

"He has not quite the oratorical ability of Professor Langley, and suffers from a slight impediment in his speech; but he has a smooth, clear voice, with a use of it, at times, quite clergymanic."

He was sometimes accused by hypercritical persons who occupied seats in the front row, of having spoken too loud. But he justified himself by saying: "I always try to remember that there may be a deaf old gentleman at the back of the hall who is entitled to hear what I have to say."

He often wound up a lecture with a quotation. There was one beginning: "But number every grain of sand" which was a special favourite. He would use it when attempting to give his audience some idea of the vast number of stars in the firmament, and it was the closing passage in the lecture which he called "An Evening with the Telescope." I discovered amongst his correspondence a letter from Mr. Allingham (February 19th, 1883) which shows that he obtained these beautiful lines from the poet himself:

"We have reason to be grateful when one who can speak with authority brings the results of science within the range of ordinary human intelligence and sympathy. I wish I could hear your discourses on astronomy, and hope to read them soon. May I venture to enclose you a little poem, written some years ago? It may be thought an extravagant way of suggesting to the imagination the number of suns—but is a kind of protest against the narrowing tendency of naming numbers when speaking of the innumerable.

"I had the pleasure of being introduced to you off the Eddystone Lighthouse, and of walking with you round the Dean's Garden at York."

He brought in a part of Mr. Allingham's verses which were called, "In a Cottage Garden," by thus concluding his lecture on "An Evening with the Telescope":

"As I return to my house after spending an evening at the telescope, the fact which chiefly dwells with me—the fact which oppresses me with its magnificence, and overwhelms me with its sublimity—is the greatness of that host of stars which no man can number. If we have been baffled in the attempt to count the stars whose photographs are recorded upon that picture now before you, if we have been staggered by the conception that the myriad suns there represented only form the ten-thousandth part of the total number of suns with which the glorious canopy of heaven is inlaid, what are we to say to the conception which I have now to bring before you? Think of the most distant star on that picture. I am sure I know not which it is. It may be this one, or this, or that; I am not concerned with the hundreds of millions of millions of miles by which that star may be separated from us. The point I really want to urge is, that the distance of the most remote star is finite, whereas the surrounding space is infinite. Imagine a vast globe—a globe of such huge proportions that it shall include within its tremendous compass all the stars that are there shown, and indeed all the stars that can ever be represented on the most sensitive photographic plate. We can tell the diameter of this globe. But yet its dimensions are finite; around it is the infinite. This vast globe, which would include within it every object on which the eye of man has ever yet looked, is merely a dewdrop, while boundless space is an Atlantic Ocean. If within that dewdrop there are a hundred million glorious suns and systems, what shall we say of the suns and systems in the infinite space beyond, where not improbably every part may be well furnished with stars. Judged by all analogy, the stars that we know, amazingly numerous as they may seem, would have to be multiplied by millions and by millions ere any conception could be obtained of the number of suns in the universe. I do not trust to my own language to give expression to the bewilderment which attends our efforts when we try to realise the number of the stars. I shall invoke the aid of the poet to express the innumerable, and conclude by repeating a few lines by Allingham:

"'But number every grain of sand,
Wherever salt wave touches land,
Number in single drops the sea,
Number the leaves on every tree,

Number earth's living creatures all,
That run, that fly, that swim, that crawl;
Of sands, drops, leaves, and lives, the count
Add up into one vast amount,
And then for every separate one
Of all those, let a flaming sun
Whirl in the boundless skies, with each
Its massy planets, to outreach
All sight, all thought; for all we see
Encompassed with infinity,
Is but an island.' "

Anecdotes of a simple and humorous character were often related in the popular lectures.

For example, he used to begin the lecture on "Krakatoa" thus:

"I understand that the announcement of this lecture has mystified many excellent people. A few days ago a friend stopped me in the street and said: 'What is this you are advertised to lecture about?' I replied, of course: 'About Krakatoa.' 'Oh, indeed,' said the gentleman; 'about Krakatoa. How very interesting! But who was *he?*' You see, the very word 'Krakatoa' is so suggestive of doughty deeds and valorous enterprise that my friend evidently thought the hero of the lecture was some renowned Irish chieftain of the ninth century, whose prowess in battle I was about to sing.

"The next time I was asked the same question I tried to anticipate the difficulty. I said at once that I was to lecture on the 'Eruption of Krakatoa.' This, however, did not answer, either. In these days we hear so much of germs, and of bacilli, of epidemics, and of influenza, that my acquaintance evidently supposed that the *eruption* of Krakatoa was some brand-new kind of sickness that had suddenly broken out to harass yet once more our frail tenements of clay. Accordingly he said: 'Oh, I didn't know you thought yourself an authority on medical matters.' And then he too moved on."

Again, in the course of his lecture, "Recent Researches about the Sun," he said:

"I had occasion to make use of the word 'carbon' in a recent lecture, and I thought when doing so that I was using a term with whose meaning all my acquaintances would be familiar. But I found out afterwards that I was mistaken.

I was told that my introduction of the word had puzzled some members of the audience. I learned that a few of those who were unfamiliar with this word went to a scientific gentleman of their acquaintance to get an explanation of this mysterious word 'carbon,' whereupon he told them that he was not quite sure himself, but that he believed it was made of nitro-glycerine."

He began another of his lectures in the following way:

"May I begin by telling you a little personal experience that I had a short time ago, when I visited another town—no matter where—to give a lecture on 'Other Worlds Than Ours'? The secretary, to whom I was personally a stranger, had courteously written to say that he would come to meet me at the station on my arrival. He told me that when I reached my journey's end I was to be on the look out for someone on the platform who might look like a secretary. There were many passengers, and the station was full of people. Amongst them, however, I noticed one very active individual who was rushing about scrutinising everybody carefully, and I thought perhaps he might be the person I was to meet; but after he had looked me over from top to toe, and had turned disdainfully away, I concluded that I must be mistaken.

"Gradually, however, the passengers departed, until there was no one left in the station but this active individual and myself, and after another look he came up to me and said: 'Well, it is very strange, but I am here by appointment to meet Sir Robert Ball, and he has not come.' 'But,' said I, 'I am Sir Robert Ball.' 'What,' said he, 'you Sir Robert Ball? Good gracious! I expected to see a careworn creature in blue spectacles; but as to you—why, you look like a fellow that could enjoy himself!'"

In yet another lecture he told his audience how:

"Some years ago, when I was in America, I visited Professor Marsh, the distinguished geologist in Yale College. He was then engaged in putting up the skeleton of a wonderful fossil animal which he had discovered in the Rocky Mountains of Colorado. This creature was indeed of colossal proportions. For two years Professor Marsh and a large staff of men had been engaged in carefully exhuming the bones of this reptile, which was more than one hundred feet long, and must have been at least thirty feet high. In recognition of the fact that

it was the most splendid four-footed beast which has ever graced this earth, Marsh called it the *Atlantosaurus*. He showed me the thigh-bone of the mighty animal. The picture before us represents the cast which he was kind enough to present to the authorities of the Natural History Museum at South Kensington. I could not help saying to Professor Marsh that next to the Falls of Niagara the skeleton of the *Atlantosaurus* was the most interesting and valuable object in the United States. Raising his hat, he said: 'I thank you for that compliment to the Rocky Mountains.'"

Lecturing at Newry on October 8th, 1894, on "An Evening with the Telescope," he had occasion to dwell upon the difficulties which would beset the man in the moon; "The day would be thirty times as long as our day, and the night thirty times as long as our night, while the temperature would be something like 200 degrees below zero during the night. But the inhabitants would have this consolation: that they would be well heated during the following day, when the temperature would be from 200 to 300 degrees above boiling point!"

VI.—*Correspondence Relating to the Lectures*

During his career as a lecturer my father used to receive curious letters from all sorts of people. If his correspondent showed some glimmering of intelligence it was his practice to send a courteous reply; but letters from persons whom he called "flat-earth men" were consigned to the "Paradox Box" in his study.

On November 26th, 1898, he wrote to Dr. Rambaut:

"As you know, I do not care for controversy. I have never even attempted to convert a circle squarer! The flat-earth men may believe the earth to be concave if they like. Controversy is only possible with a mathematician and about a mathematical point. There is then some chance of a clear issue, and a certainty that each will at least understand and respect the other."

The true "flat-earth men" did not spare him. Here is a characteristic letter from the celebrated John Hampden*:

* He was plaintiff in a case well known to lawyers, *Hampden* v. *Walsh* (1876), 1 Q.B.D. 190, wherein he claimed to recover a sum of £500 which he had deposited with the defendant as stakeholder upon the result of a wager with Mr. A. R. Wallace. Chief Justice Cockburn thus referred to the plaintiff in his judgment: "The plaintiff,

"In the approaching discussion at Southport, I understand you are to introduce the subject of the distance of the sun. Allow me most respectfully to say that I shall challenge you to show that any reliance is to be placed on observations made on the hypothesis that the earth is a globe and rotating on an axis before a fixed sun. No man, be his scientific attainments ever so high, has the right or ability to discuss this subject on faulty and mistaken premises. It may be very mortifying to have to go back to the very A B C of your system, but the time has passed when you can rely on meeting with no opposition to the baseless conjectures of the heathen astrologers. The distance of the sun depends wholly and entirely on your knowledge of the shape of the earth. Of that you are totally ignorant."

The same authority wrote on another occasion:

"Referring to a lecture given by you a few days ago in Dublin, allow me to say how astonished I am that any man can be found at the end of the nineteenth century to utter the scandalous falsehoods such as you then repeated with respect to the sun's distance from the earth. You must *know* such statements to be false, and you dare fool your ignorant dupes with these scandalous fictions, which only the devil himself could have invented. If the sun is ninety-three million miles distant, how would the temperature be 120° at the equator and 50° below zero at the north, a triangle having only 2,000 miles base, with the other two sides 93,000,000? Considering what we spend in education, I consider such monstrous *lies* perfectly scandalous. I will expose you, never fear."

it appears, entertains a strong disbelief in the received opinion as to the convexity of the earth, and with the view, it seems, of establishing his own opinion in the face of the world, he published in a journal called *Scientific Opinion* an advertisement in the following words:

> "'The undersigned is willing to deposit £50 to £500 on reciprocal terms, and defies all philosophers, divines and scientific professors in the United Kingdom to prove the rotundity and revolution of the world, from Scripture, from reason, or from fact. He will acknowledge that he has forfeited his deposit if his opponent can exhibit to the satisfaction of any intelligent referee a convex railway, canal, or lake.'"

Mr. A. R. Wallace having taken up the challenge, experiments were carried out on the Bedford Level, with the result that Mr. Walsh (the defendant) who also acted as referee, decided in favour of Mr. Wallace, "as having proved to his satisfaction the curvature to and fro of the Bedford Level Canal between Witney Bridge and Welsh's Dam (six miles) to the extent of five feet, more or less." The plaintiff apparently did not regard Mr. Walsh as an "intelligent referee," for he demanded the return of his deposit, notwithstanding which the defendant paid it over to Mr. Wallace. It was held, for legal reasons into which it is not necessary to enter, that the plaintiff was entitled to recover.

To critics of this calibre my father appears to have applied the maxim:

"The noblest answer unto such
Is perfect stillness when they brawl."

He sometimes referred publicly to the letters which he received. For instance, he began his lecture on "Invisible Stars" by saying:

"I have received a letter. Here it is. I am not going to tell you the address; it does not now concern us. I am not going to tell you the name of the writer from whom it comes, because I don't know that myself. The communication is anonymous, but I will just read it to show you the style of thing I have to submit to:

"'It is announced that you will lecture this evening on what you call "Invisible Stars." If those stars are invisible, I beg to ask whether you have ever seen them? [There is internal evidence that the writer of this letter is a countryman of mine.] Must not a lecture on "Invisible Stars" be about as entertaining as a concert of inaudible music? Did you ever detect the perfume from an inodorous flower?

(Signed) "'AN UNBELIEVER.'"

"Of course, there is a postscript:

"'*P.S.*—I shall be there.'"

A communication which he often mentioned with delight is quoted in a letter dated November 13th, 1889—Shooting Star Night—written at the end of a lecture tour:

"I have had a fine time of it, and among my audiences I have had three real Bishops, a Prince of Siam, a ditto of Roumania, and a host of such people as ordinary lords, earls, and common deans and other Church dignitaries, not worth mentioning. All these people have been drawn out of their several boots by a new and blood-curdling kind of eloquence which I have adopted to the utter confusion of everybody. At Tunbridge School, W. was most anxious that I should read a letter from the grocer who desired to become an apprentice at Dunsink.

"We had not the letter, of course, but we recomposed it with such judicious improvements as would lead to the culminating and awful sentence commencing, 'My mind finds no rest,' which is perfectly genuine. Here is the letter:

"'MOST HONOURABLE SIR,

"'I am a grocer's assistant, but my spirit is above the selling of tea and sugar, and longs for communion with the skies.

Could you take me as an apprentice in your Observatory? I pass many a sleepless night yearning for the sympathy of the planets. As I weigh out twopennyworth of figs in the balance I think of Libra the constellation, and long to soar aloft amid the celestials. The pair of children that have just come into the shop make me wish myself to be the Heavenly twins, and when they asked for bull's-eyes, I thought of the constellation of Taurus and the bull's-eye that twinkles above. In fact, dear sir, and most honoured individual, my mind finds no rest for the sole of her foot save on one of the heavenly bodies!'

"The result was prodigious and fully justified W.'s anticipation of success."

An anxious parent asked for advice as to how to make his son an astronomer:

"I want to talk to you about my boy. . . . Will you guide if I steer, I mean, pay? He has most wonderful eyes for 'star-gazing.' Do think, and let God do the rest. He was born near the Karoo, Africa, and that is the place for sight and clearness.

"Do give me your prop!"

In real or pretended ignorance of the true function of an astronomer many people used to make inquiries of Sir Robert as to the weather. He was often heard to put them off by saying that the domain of an astronomer only starts at a distance of 240,000 miles from the earth and ends at infinity. But it is manifest that some people refused to be put off by any excuses.

Thus he received the following letter from a lady who was a complete stranger to him:

"I am contemplating a visit to Syria—and have thought that to go by way of the Bay of Biscay and through the Straits of Gibraltar would be the most enjoyable, provided one could ensure fine weather for the voyage. This is my first experience of such travel, and I do not, personally, know anyone who could advise me on the subject. I should feel very grateful if you would favour me with a reply to my queries *re* forecasts of weather and such like."

Problems of a recondite character, suggested, apparently, by the relative motions of the heavenly bodies, were sometimes presented for solution. The following is from a letter dated January 31st, 1897:

"I shall be much obliged if you will kindly give me an authoritative opinion on the problem of the person going round a pole

with a monkey on the top—the monkey twisting round on the top with face always opposite to the person going round. The question is whether the person goes round the monkey or not, and as there have been many disputes on the point, it has been agreed that your opinion is to be final and conclusive."

From artists he received at least two letters. A painter in Clerkenwell wrote:

"I have an emblematic oil-colour painting, painted by myself, of 'The Landing of Truth.' The emblem that I have employed is a fine-shaped woman in the nude landing from a rough sea, having reached the shore by the means of a buoy. By the landing of Truth, I mean, the recently discovered truth that it is from the sun that we mankind, and all living things, both vegetable and animal, derive our lives and beings. As I surmise, sir, you believe in this natural and exhilarating definition of the mystery of life, I thought you would like to avail yourself of a painting illustrating the subject; if so, I shall be glad to let you have it at a reasonable price."

A second artist appears to have asked her sister to write to the astronomer about:

"'The Position of the Sun as affecting the painting of a picture.'

"Excuse the liberty I am taking in writing to you on the above subject, but it is on behalf of my sister, who is troubled as to when the sun will allow her to finish a picture she is painting of an interior in Oxford. She was engaged on an interior from March 15th to end of the month. The sun shone then through certain small windows, and she is anxious to know when she can get the same rays of light again, so that she may arrange to continue her work. She has been told by some people that about September 15th she can start again, by others, not until the same time next year. She would be greatly obliged if you would kindly advise her as to when she might expect to get the same effect for her picture."

I only know of his being annoyed at one of his numerous correspondents. It was a clergyman who, when Mars was in opposition, wrote to say that certain of his congregation were disturbed in mind as to the prospect of a collision with that planet. He [the reverend writer] desired to have from the Astronomer Royal "a few words which he might read from the pulpit to reassure his flock." As might be expected, Sir

Robert took no notice of this letter. It was consigned to the "Paradox Box." But he was somewhat incensed when a few weeks later he received another letter in which the same cleric expressed the view that "public servants might at least *acquire* courtesy!"

Sometimes, if occasion suited, a bantering reply was vouchsafed. On one occasion a dear old lady who had been reading "The Story of the Heavens" said she quite understood that the path of the earth, in its course round the sun, was elliptical, and that the sun was at one of the foci of the ellipse. Here, however, she was at a loss. She did not know which of the foci occupied this proud position. Sir Robert's reply raised a nice problem in orientation. He wrote on a post card: "The right-hand one."

A gentleman wrote from a town at which my father was about to lecture asking him to state whether it was true that "Mars was inhabited by a very fine race of people, the men being 9 feet 3 inches in height, and the women so beautiful that words cannot describe them."

This is what he said about possible inhabitants of the Ruddy Planet in the lecture entitled "The Eternal Stars":

"I can tell you nothing of these inhabitants. I do not know what they are like, or how big they are, or what clothes they wear, or what dwellings they inhabit, or whether they are scattered over the country or are collected together in cities. We really know nothing of them. They may be five feet high, or five inches high, or fifty feet high, for anything we can tell. The inhabitants on Mars may be more like birds or fishes than like men or women. In one of his famous imaginary sketches Voltaire said that when the inhabitant of Saturn was interrogated about life on his planet he was asked, among other questions, how many senses he had. The Saturnian immediately replied that 'the inhabitants of Saturn had seventy senses, and that every day they lived they regretted they had so few.' I know nothing as to the inhabitants of Mars. Even in my most sanguine moments I never expect to know anything beyond just this—that Mr. Lowell's observations appear to show that work conducted by intelligent agents is at present in progress in Mars."

A little later he said:

"It certainly seems that the inhabitants on Mars, whoever

and whatever they may be, have at least this much in common with us dwellers on the earth—that water is essential to their existence. Sir Wilfrid Lawson, at all events, will be gratified to learn this fact!"

I may add to this what he said as to the possibility of there being life on Venus:

"If there be life upon Venus, and I prefer to think that the Evening Star is the abode of life, we may be assured that the inhabitants, whatever they are like, will dwell on the sunny side, and night will be to them unknown. The other side, where not a ray of sunlight ever falls, will be a desolate wilderness, less known to the denizens of the favoured regions than our North Pole and South Pole are to the dwellers on this earth. For the inhabitants of Venus there would be no pleasant transition between hours of activity and hours of soothing repose. The arrangement might, however, be very suitable for the development of vegetation on Venus. It seems to have been proved that though plants slumber through the hours of darkness, they will grow continuously if continuous light be given. If electric light be supplied in mitigation of night, it has been shown that vegetation will progress far more luxuriantly than when such assistance to Nature is withheld. We must imagine the splendour with which the tropical forests on Venus might unfold their leaves to a sun, whose rich and warm beams were never for a single moment intermitted."

The moon appeared to trouble some of his correspondents. A lady writing from Ireland said:

"May I ask you kindly to excuse me trespassing upon your time, in asking for an answer to the following question, which has puzzled so many friends:

"Have the moon's rays power to whiten stone? There is a beautiful church near here built about ten years ago of a kind of basaltic stone, the belfry of which is a model of a round tower. A portion of it facing the moon has become whitened, also a side of the church facing the same direction. Abroad we see marble statues and pillars whitened at the side facing the moon and dark at the opposite side, and here in the north of Ireland the linen is said to bleach best in the moon's rays. Can this influence be true, or are we moon-struck in coming to this conclusion?"

A gentleman who seemed to be disturbed about the behaviour of the moon in the Arctic regions wrote:

"I cannot realise to myself what the behaviour of the moon is in the Arctic regions, and I can find no reference to the subject in your books or those of other astronomers who have written text books for the instruction of the general public.

"I know that the altitude of the moon is greater in winter than in summer, and I imagine that it must be half a lunar month above the horizon and half below. Travellers in the far North say a great deal about the sun but very little about the moon. Will you kindly write in the enclosed envelope the name of a book which will solve my difficulty, and pardon me for encroaching on your valuable time?"

A lady, writing to my father, wanted to know "by return of post" whether it was true that the earth was coming to an end very soon owing to the rapid approach of Hercules. "If it is true," she said, "nothing except Church work seems to be worth doing; and I can get no relaxation of mind with this thought in the background." Whether the good lady (who hailed from somewhere north of the Tweed) restricted her energies to Church work does not appear. She seems to have received no answer. Another lady, writing in the same year, thought "that the earth had got out of its course and was making off to Jupiter."

A clergyman in the south of England held the view that the New Jerusalem was situated at the back of the moon. Hearing that Sir Robert was about to lecture in the neighbourhood, he determined to submit his theory to the judgment of an expert. He even went to the length of button-holing the astronomer upon his arrival at the station. "What do you think, Sir Robert? Is not the back of the moon, which we have never seen, likely to be the New Jerusalem?" "I should think," said the astronomer slily, "that you would be more likely to find it at the back of Mars!" With this answer the divine was content. If the Lowndean Professor had not accepted the proposition in its entirety, at least he had not ruled it out altogether.

Let it not be supposed, however, that all the letters which he received relating to his lectures were consigned to the "Paradox Box." He was grateful to many a correspondent who suggested a correction or opened up some new line of thought. Of such letters, which he received in countless numbers, I print but two. The first relates to the meteoric

shower which was expected in 1899. Professor H. A. Giles wrote on November 7th, 1899:

"After hearing your interesting lecture last night, it occurred to me to see if I could find any record of meteoric showers in Chinese authors. I venture to send you the result of a desultory search. Entry No. 2 referring to the year 1035 seems to be somewhere about the mark."

My father replied on November 10th:

"Many thanks for your kind letter. The extracts you give are very interesting, and I am very glad to have them. As you say, the date A.D. 1035 corresponds very well with the Leonid shower, but the stones found I should expect to be apocryphal. At any rate, there is no authentic evidence whatever of meteors in the Leonid shower throwing down stones or particles that could afterwards be recovered or recognised.

"Doubtless much attention will now be given to the subject, and I am sure that such records as you have found will be very valuable.

"As to the shower in 685 B.C., the fact that the season was summer and some other circumstances seem to point to the conclusion that this was not a display of the Leonids, but perhaps it may have been a display of the Perseids or August meteors."

The second letter was received at Cambridge in January, 1893, from the famous novelist, Ouida:

"DEAR SIR,

"I think it may interest you to know that I several times in the past year saw with my unaided eyes two of the satellites of Jupiter. I wish you could see the stars and planets from my terraces and tell me all about them. Would you mind telling me by letter in which constellation the star Altair is to be found?

"Accept my compliments and allow me to remain faithfully yours."

VII.—*A Lecture to Convicts*

I have pointed out that my father seldom lectured without fee. On one occasion, however, he gave his services for nothing in circumstances which are sufficiently remarkable.

In the spring of 1907 he was making holiday in Devonshire, and on March 4th he received the following letter from the chaplain of Dartmoor Prison:

"As you will be in this neighbourhood on the 13th or 14th inst., I am venturing on behalf of the largest body of convicts

in the kingdom to make a request which I can only trust may meet with your sympathy.

"With the permission of the Directors of Convict Prisons a few lectures are given each winter season to the whole body of the men here, brought in from labour for the purpose. These lectures are very popular with the poor fellows, and it has been found that they tend very considerably towards their mental and moral improvement. They are on various subjects (except religion), and you will readily understand that they give the men something to think about, and take them for the time out of themselves. Will you, sir, when so near us, spare us an hour for one of your charming discourses? My excuse for the boldness of this request is simply the happiness and delight your undertaking so kind an act would give to hundreds at the penal settlement."

My father accepted the invitation, and a day or two later the Governor (Mr. Basil Thomson) wrote to say that the lecture would be given at noon on March 14th. He added:

"There will be an attendance of 900, among whom, besides the ordinary labourer, are many intelligent and well educated men—lawyers, a parson or two, forgers, long-firm swindlers, and professional burglars. It is therefore a mixed audience in more senses than one."

Writing to advise me of the fact that he had consented to address the convicts, my father said:

"DEAREST BILL,

"If you want free tickets for your friends to hear a lecture of mine, now is their chance! Let them hurry up and commit bigamy, or arson, or any really good felony short of actual murder and they will have a free ticket, indeed, a compulsory ticket forthwith!

"I lecture to the convicts at Dartmoor on Friday. (Fact!)

"*P.S.*—I shall have both clergymen and *lawyers* [the italics are his.—ED.] in my audience, I am told."

To Princetown he went on March 14th, and duly delivered his lecture.

Writing to Mrs. Millington a few days later, he said:

"My experience at the prison was very curious. I lectured to 950 convicts, including, as they were particular to tell me, the very worst scoundrels on earth. But a more pleasant and sympathetic audience there could not be. I would like to tell you all about it some time. When I remarked on the fact that

not over a dozen of the prison officials were present, to 950 convicts, the answer was simple: 'The convicts never combine.'

"The Governor told me that no lantern could be used, as it would be impossible to allow so many convicts to assemble in a darkened room. I was therefore compelled to illustrate my remarks by drawing with chalk on a blackboard. When I mounted the platform I saw rows and rows of closely cropped heads in front of me. In the gangways on either side warders were mounted upon what looked like step ladders, from which they could get a clear view of the audience. The gallery at the back of the room was reserved for the more desperate characters. Having regard to what I had been told as to the social position of some of the convicts, I was at a loss to know whether to begin in the customary manner. Was I to address them as 'Gentlemen'? I solved the problem by commencing straight away without any introduction."

If he found it difficult to begin a lecture in such surroundings, he might well have found it doubly hard to go on; but his courage and experience on the platform stood him in good stead. He told them of the appearance of a new star, and said: "A few years ago a new star appeared in the sky. It suddenly blazed forth with wonderful brilliance. On a fine night when it was at the zenith of its glory I set out to walk from King's College, Cambridge, to my home at the Observatory. I was so much impressed with the brilliance of the new celestial body that I determined to point it out and explain its remarkable appearance to everyone I met. Amongst other people I encountered was a policeman. Having given the officer a short history of the star, I adjured him to mark it well, as he might never see such a thing again. The constable replied: 'All right, Sir Robert, I'll keep my eye on it!'"

The audience shook the building with an outburst of applause, and the lecture was a huge success.

That it produced some effect upon at least one member of the audience is apparent from a letter which reached Cambridge some time afterwards:

The envelope was addressed:

"Professor Bird (or Black),
"Obsowatory,
"Cambridge."

The letter was written in pencil, on a bill headed with the

name of a man who described himself as a "builder and steeple contractor." The contents were as follows:

"DEAR SIR,

"please to excuse my intrusion, but after listening to your lecture at Dartmoor Convict prison It made a deep impression upon me and meny hundred sorrowful hearts blessed you, and it was even the talk up till my release a few months ago. I wish to retreave my Character and circumstances, and something give me the instinct after seeing you stand and laugh while we clapped in gratifulness, especially when you mentioned the boby said he would keep his eye on that star, and the person falling off the ladder, etc. I send you the bill head as a proof of my possion and circumstances till this misfortune befel me, and if you can assist or send some acquaintance to see me and enclose this letter I will feel grateful. I am on 119 days ticket-of-leaf, and then you know how cricital my position is till that expires. I ever wish to remain your truly —— ——. Will await every post in hopefulness. Oh! if I only had you near me personally to converse with you, I could tell you more of your lecture."

The lecture at Dartmoor was Sir Robert's first, last, and only appearance before a criminal audience. In November, 1911, he was invited to lecture at the Feltham Borstal Institution, but he was unable to accept.

VIII.—*More Advanced Lectures*

The popular lectures through which my father became so widely known to the British public were upon astronomy. The recondite "Theory of Screws," to which he devoted the best years of his intellectual life, was little known to those who delighted to hear him on the platform. The subject was too abstruse, if not too sacred for such treatment.

I, who am no mathematician, once asked him to explain the Theory of Screws. His reply was notable. He said: "If I were to begin speaking now, and continued to expound the subject for about six months without interruption, you might have some faint glimmering of what it means!"

But the great "Theory" was well known to mathematicians in all parts of the world. I remember the delight with which he told me that a course of lectures was being given in a German university on "*Die Ballsche Schrauben-Theorie.*" Yet on one occasion he did attempt to deal with the "Screws" in a comparatively simple way. When the British Association met

at Manchester in 1887 the Astronomer Royal of Ireland gave an address to the Mathematical Section of the Association. It bore the attractive title: "A Dynamical Parable."

Before delivering this address he had submitted a copy to Professor George Francis FitzGerald, who wrote on July 7th, 1887:

"I think your address is 'quite splendid,' as they would say across the water. I am afraid I am a rather useless critic, for I have little or nothing to criticise. If you could have introduced more conversation at the beginning it would be livelier. Mr. Querulous might have stood up for Mr. Cartesian's methods! I think 'Parable' better than 'Allegory,' for 'Allegory' would connote that the story was about something quite different from what its second meaning was like, and 'Story' is rather too colloquial.

"I think when you bring out a new edition, or a complete edition, of your 'Screws' you should put this in as an 'Introduction.'

"Of course, a thing of the kind could be drawn out with conversations almost indefinitely, and I think you have on the whole struck a happy mean, though the latter part is more conversational, and, as such, livelier than the beginning—but then people require more stimulating things for their palates at the end of dinner. If you could divide Mr. Anharmonic's long speeches between him and a Mr. One-to-One it would relieve them, but then it would take more time. You might introduce into Mr. Querulous, Purser's great objection to Quaternions, that what we want is analysis and not a complex quantity like a screw to deal with. We want the geometry analysed into its simplest components and not left in a complex state. Purser always objects to Quaternions because there is so much involved in q that you might as well deal with the original things. You want quantities to deal with whose laws are simple. This in a general way would apply to screws, and might be introduced in favour of Mr. Cartesian's methods.

"However, I must stop this wild attempt to gild refined gold."

I venture to quote the opening and closing passages of the famous "Parable." Needless to say I make no attempt to explain them:

"Ladies and Gentlemen,—The subject I have chosen for my address to you to-day has been to me a favourite topic of meditation for many years. It is that part of the science of

theoretical mechanics which is usually known as the 'Theory of Screws.'

"A good deal has been already written on this theory, but I may say with some confidence that the aspect in which I shall invite you now to look at it is a novel one. I propose to give an account of the proceedings of a committee appointed to investigate and experiment upon certain dynamical phenomena. It may appear to you that the experiments I shall describe have not as yet been made, that even the committee itself has not as yet been called together. I have accordingly ventured to call this address 'A Dynamical Parable.'

"There was once a rigid body which lay peacefully at rest. A committee of natural philosophers was appointed to make an experimental and rational inquiry into the dynamics of that body. The committee received special instructions. They were to find out why the body remained at rest, notwithstanding that certain forces were in action. They were to apply impulsive forces and observe how the body would begin to move. They were also to investigate the small oscillations. These being settled, they were then to—— But here the chairman interposed; he considered that for the present, at least, there was sufficient work in prospect. He pointed out how the questions already proposed just completed a natural group. 'Let it suffice for us,' he said, 'to experiment upon the dynamics of this body so long as it remains in or near to the position it now occupies. We may leave to some more ambitious committee the task of following the body in all conceivable gyrations through the universe.'

"The committee was judiciously chosen. Mr. Anharmonic undertook the geometry. He was found to be of the utmost value in the more delicate parts of the work, though his colleagues thought him rather prosy at times. He was much aided by his two friends, Mr. One-to-One, who had charge of the homographic department, and Mr. Helix, whose labours will be seen to be of much importance. As a most respectable, if rather old-fashioned, member, Mr. Cartesian was added to the committee, but his antiquated tactics were quite outmanœuvred by those of Helix and One-to-One. I need only mention two more names. Mr. Commonsense was, of course, present as an *ex-officio* member, and valuable service was even rendered by Mr. Querulous, who objected at first to serve on

the committee at all. He said that the inquiry was all nonsense, because everybody knew as much as they wished to know about the dynamics of a rigid body. The subject was as old as the hills, and had all been settled long ago. He was persuaded, however, to look in occasionally. It will appear that a remarkable result of the labours of the committee was the conversion of Mr. Querulous himself.

"The committee assembled in the presence of the rigid body to commence their memorable labours. There was the body at rest, a huge amorphous mass, with no regularity in its shape—no uniformity in its texture. But what chiefly alarmed the committee was the bewildering nature of the constraints by which the movements of the body were hampered. They had been accustomed to nice mechanical problems, in which a smooth body lay on a smooth table, or a wheel rotated on an axle, or a body rotated around a point. In all these cases the constraints were of a simple character, and the possible movements of the body were obvious. But the constraints in the present case were of puzzling complexity. There were cords and links, moving axes, surfaces with which the body lay in contact, and many other geometrical constraints. Experience of ordinary problems in mechanics would be of little avail. In fact, the chairman truly appreciated the situation when he said that the *constraints were of a perfectly general type.*"

The discussion lasted for a considerable time, until:

"The chairman said he feared it was beginning to enter rather wide ground. For his part he was content with the results of the experiments, even though they had been conducted in the vapid old space of Euclid. He reminded them that their labours were now completed, for they had ascertained everything relating to the rigid body which had been committed to them. He hoped they would agree with him that the inquiry had been an instructive one. They had been engaged in the study of Nature, they had approached the problems in the true philosophical spirit, and the rewards they had obtained proved that

'Nature never did betray
The heart that loved her.'"

The address was subsequently published in pamphlet form. In thanking him for a copy, Professor Niven (Aberdeen) wrote (September 5th, 1887):

Lectures on Astronomy

"I have to thank you for the copy of your address as President of Section A which you have sent me, and which I have already seen in the *Mail*. I have read it with a great deal of interest, though, I fear I should have to class myself as a cross between Mr. Cartesian and Mr. Querulous. Not since the time of Galileo has an attempt been made to combine wit and wisdom in this manner, and not everyone would venture on the experiment with much hope of success."

My father gave several courses of lectures to advanced students at Cambridge. He thoroughly enjoyed this part of his work. Writing to Dr. Rambaut (October 17th, 1897), he said:

"I am just beginning my lectures here on the Planetary Theory. You like the observatory work the best, but whatever I may have once thought, I now greatly prefer the lecturing, especially when I have so magnificent a subject."

He also lectured on "Screws," but apt pupils were few in number. He wrote to Professor Joly (July 12th, 1900):

"I have announced a few lectures on Screws this Long Vacation, and I have heard of one man who was coming, and there may perhaps be others; three would be considered a good class here in anything of this sort. Any man who does come to a class of the kind always does so very seriously, attends every lecture, takes careful notes, reads up the subject and never drops off, but they reflect maturely before beginning it. The man who is coming to me knows a good deal about the subject already, so I think of commencing with the Dynamical Theory of Impulsive and Instantaneous Screws."

CHAPTER XI

SCIENTIFIC ADVISER TO THE IRISH LIGHTS BOARD

IN the year 1882 my father was appointed Scientific Adviser to the Irish Lights Board, in succession to the late Professor Tyndall, who had held the post for a number of years.

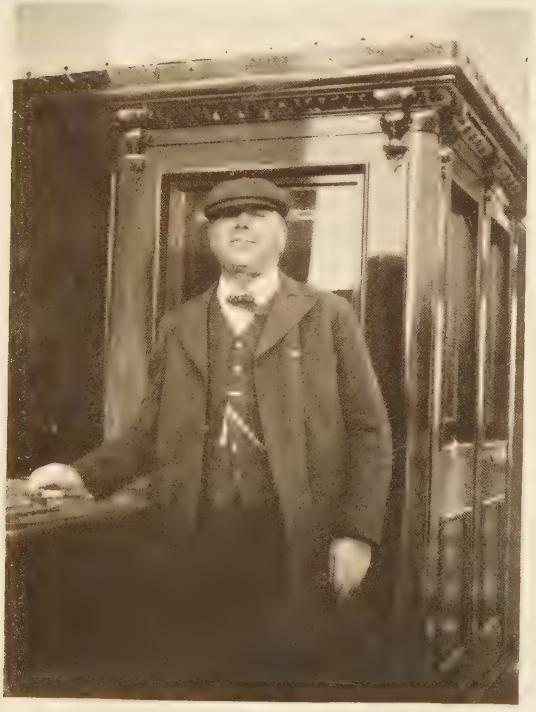
It was his duty to advise the Commissioners of Irish Lights as to the efficiency of the apparatus used in the Irish lighthouses, and to investigate the claims of inventors who from time to time came forward with new-fangled lenses and illuminants.

Were the Commissioners undecided as to whether a particular form of lantern should be adopted, he was consulted. Was it suggested that the electric arc would better serve to penetrate the mists which shroud the Irish coast from the eyes of the passing mariner, his opinion was sought.

In 1884 he made a report to the Commissioners on the results obtained in a series of experiments on lighthouse illuminants. The relative merits of gas, electricity, and oil had been put to a practical test at the South Foreland. In the report he states his conclusion on this important question:

"I am convinced of the truth that for practical purposes a 108 jet gas burner is substantially the same as the seven-wick oil lamp, the gas having perhaps a slight advantage in fixed lenses and the oil in revolving lenses. . . . The question as to the relative powers of gas and electricity in illuminating during fog seems to be still in a condition of uncertainty. It seems to have been shown that in moderately thick or misty weather the electric is much the best light, as it is, of course, in fine weather. It seems, however, from the important observations on November 24th that in a fog which extinguished all lights at three and a half miles, the oil and gas were found at a distance of two and a half miles to be each superior to the electricity. On the other hand, on September 9th, when full fog powers were used, all were extinguished at 1,600 feet, and on walking in, electricity appeared at 1,500 feet, and gas and oil together at 1,400 feet.

THE *PRINCESS ALEXANDRA*



THE SCIENTIFIC ADVISER TO THE IRISH LIGHTS COMMISSIONERS

Scientific Adviser to Irish Lights Board

On December 6th the engineer at the South Foreland reports that a dense fog prevailed, and that all three lights are equal and only just visible at one and a quarter miles.

"So far as these experiments go they seem to prove that the preponderating splendour of the electric light is greatly reduced in a dense fog, but they do not afford me the materials for any definite conclusion as to the relative value of electricity to the other illuminants in that weather when powerful lights are most needed."

He did not hesitate to set his opinion against that of the Board of Trade. He wrote to the secretary to the Commissioners (July 11th, 1891):

"At the request of the Inspecting Committee I have had under consideration a letter of the Board of Trade, dated April 30th, 1891, with reference to the Kinsale Light. I understand from this letter that the Board of Trade suggest that an eight-wick occulting biform light would suffice for the requirements of Kinsale. If I have understood this proposal aright, it is one in which I cannot acquiesce, as it does not seem to present any considerable advantages over the scheme for a ten-ringed burner in the present optical apparatus.

"In support of this opinion I submit the following considerations. We know that in an ordinary fixed light the central drum transmits seven-tenths of the light, the upper prisms two-tenths, and the lower prisms one-tenth. Where two optical systems are combined, as in the biform, there is, of course, a sacrifice of both upper and lower prisms, and consequently if ten be the power of the single apparatus, the power of the biform may be represented as fourteen. But this is on the supposition that the two lamps in the biform are each of the same power as the single lamp in the single apparatus. It must, however, be remembered that in the single apparatus we propose to use a ten-ring burner, and, so far as the data are available, it appears that the ten-ring burner will yield at least forty per cent. more light than the eight-ring burner. From this I conclude that the single apparatus with the ten-ring burner will be practically as good as the biform with two eight-ring burners.

"My views as to the desirability of the electric light at Kinsale have undergone no change, the only object of this letter being to record my opinion that if the electric light cannot be had, there will be no advantage in incurring the large expenditure for a biform occulting light with eight-ring burners when the much simpler change of putting a ten-ring burner into the present apparatus will, it seems to me, afford as good a light."

He always regarded the office of Scientific Adviser (to which he was reappointed annually) as somewhat precarious, but his fears were diminished when Lord Rayleigh was appointed to act in a similar capacity as adviser to the Trinity House. Although at least one Chancellor of the Exchequer, with a bent for economy, was inclined to abolish the post, my father continued to hold it to the end.

He was not obliged to accompany the Commissioners on their tours of inspection, but he rarely missed this annual outing. At all events, he would join the ship for part of the cruise, and as he was a perfect sailor, the storm-tossed waters of the Atlantic had no terrors for him.

He always looked forward to the voyage with the greatest delight; not, indeed, that it gave him an entire rest from his mathematical labours, for he always took his books with him, but because it meant the society of congenial friends. His camera and his "Bentham's British Flora" (of which more hereafter) always accompanied him on these occasions.

I found amongst his papers a brief account of the commencement of a cruise in the *Princess Alexandra*. It would seem that he had it in mind to write a connected story of one of these cruises, but it was never completed. The following is but a fragment:

"Early in June, 1890, I received an invitation from the Commissioners to join the Inspecting Committee on their annual cruise around the coast. It was not the first occasion on which I made this trip; indeed, for several years past I have enjoyed a part of the cruise. I shall, however, specially speak of the midsummer of 1890. On a beautiful evening I journeyed to Kingstown, and there, at her moorings in the centre of the harbour, lay the *Princess Alexandra*, the steam yacht belonging to the Commissioners. A couple of hands met me at the station to carry down my traps, and I gladly reciprocated the hearty welcome from my old friends the members of the gig's crew. The steam pinnace awaited us at the Victoria Quay. We glided rapidly amidst the yachts across the blue waters of the harbour. On our way we saw a somewhat unusual visitor who had enlivened the harbour, I was told, for some days. It was a large and plump porpoise, which, instead of lazily tumbling about after the wonted manner of his species, jumped clean into the air as if he were look-

ing to find some way out of the harbour into which he had accidentally wandered! At the top of the accommodation ladder we were welcomed by the trusty captain of the *Princess*, my valued friend A. Knox Galwey, Esq. More than fifty times has this excellent seaman circumnavigated Ireland in the service of the Commissioners. The greater number of these voyages were for the purpose of delivering stores to the lighthouses and lightships. The *Princess* generally makes two or three such trips annually. In the summer, however, she does not carry stores. It is true that a box or two is generally to be found in the hold for delivery at each station where we touch, but the main object of the cruise is inspection.

"The departure of the vessel is generally made the occasion of a little festive gathering, so that not only those members of the Board who are actually going on the voyage are present with us this evening, but several others who have come on board to dine, and to bid their colleagues *bon voyage*.

"As the *Princess* is to be our home for two or three weeks, let us take a look at her. Her two yellow funnels are well known in every Irish harbour. Our favourite resort when under way is the bridge between the paddle-boxes. Many a pleasant hour is spent on this bridge. On the after-deck there is a deck-house, beautifully fitted, gay with geraniums and pelargoniums. It has a table well covered with books and newspapers. It also has a comfortable lounge—and be it known to land-lubbers that a nap may always be taken at sea at any hour of the twenty-four. A straight staircase from the deck-house leads into the saloon, which lies amidships. It contains a suitable library of books. At one side of the saloon hangs the roll map of the coast, which shows all lightships and lighthouses. On the solid mahogany in the centre is to be found a vase of flowers, replenished from time to time during the cruise by gifts from the shore. It is in this saloon, of course, that our meals are served. At other times the deck-house, with its more abundant light and air, is generally preferred, especially when we lie at anchor on a beautiful summer evening in some charming harbour or land-locked bay. In the after part of the vessel are seven cabins, three at each side and one at the end. Each is a distinct room. Seven is the number for which the ship is adapted. The captain has admirable quarters in another part of the vessel.

"As I have said, a few friends come down to bid us farewell. After dinner is over, and they have left, an important matter has to be decided. I should mention that one member of the Inspecting Committee is chosen by his brother Commissioners to act as chairman during the cruise. The rest of the party are for the time under his mild sway. As to the navigation of the ship, that is entirely in the hands of the captain. He, however, receives instructions from the chairman as to what it is proposed to do—as to when we shall start and when we shall stop, as to the harbours at which we shall lie, and all similar matters. The first exercise of the chairman's authority takes place after the little dinner-party is over. We are still in harbour, and the start is not to be made until early the following morning. We are to leave Kingstown and to sail round Ireland. This much is settled; but it is for the chairman to say, late at night, whether, on leaving Kingstown, we shall turn to the right or to the left—that is, whether we shall go south about or north about. This is not divulged until the last moment. The chairman has several reasons for keeping it secret. Let it be remembered that the object of the cruise is to inspect lighthouses, and that, for obvious reasons, there is no occasion to give the lightkeepers more notice of our movements than is necessary. This is one reason why the chairman does not tell beforehand which way the ship is going; but there is a better reason still. Very often he does not know himself until the last minute. He looks at the barometer, he speculates on the weather, he has a chat with his colleagues, he asks the captain's opinion, he considers whether there is any special reason for visiting Queenstown before Belfast, or Belfast before Queenstown, and finally he then gives the word. I think, perhaps, we go more frequently northwise than southwise. Some of us may have had an idea that it would be north about. At about half-past eleven, however, the oracle spoke. The sailing orders were given 'south about.'

"The duty on which the *Princess Alexandra* is bound is the annual inspection of the various establishments all round the coast of Ireland which are in the hands of the Irish Lights Commissioners, who must provide and maintain whatever lights, buoys, and beacons may be necessary for safe navigation in these waters. Their rights and duties as regards sea

marks are analogous to those of the Trinity House for England. Both bodies are under the financial control of the Board of Trade, by whom the General Lighthouse Fund is administered. The shipping of the country has to pay certain tolls for lights, and it is from this source that the lights are maintained. It is not, however, to be inferred that all lights, buoys, and marks have to be provided from this fund. At the various ports the local authorities have to maintain whatever is necessary for the guidance of vessels in and out of harbour. There are, however, a few exceptions. Certain harbours are regarded as ports of refuge to which vessels resort to escape from storms, or to await a fair wind. In such cases there is no reason why the local authorities should defray charges which should fall more appropriately on the general mercantile marine fund. To give an illustration of my meaning, I may refer to the case of Dublin. Ships arrive there to discharge cargo, and there is a cross-channel trade. The expenses of the lights are therefore defrayed by the Port and Docks Board from dues levied on the vessels frequenting the Liffey. At Kingstown there is a large artificial harbour from which the mail steam service to Holyhead is conducted; otherwise there is but little traffic, the harbour usually containing nothing but a fleet of yachts or weather-bound vessels. Yet, as it offers a refuge to ships, it is appropriate that the mercantile marine fund should provide the lights, and accordingly the Kingstown lights are under the Commissioners, while those at Poolbeg, at the entrance to the Liffey, belong to the local authorities in Dublin. I might give similar illustrations at other places. For instance, it is only right that the mercantile marine fund should provide lights and beacons at the mouth of Queenstown Harbour—a haven which provides an excellent anchorage and affords protection from all winds and waves. But the case is different if the ship entering Queenstown does so merely to convey a cargo of wheat to a merchant in Cork. Then she has to pass up the river from Queenstown, and the lights on this river are maintained by the local authorities, and not at the expense of the general mercantile marine.

"To a certain limited extent even local lights and marks come under the notice of our Board. Every few years, in the course of their annual trip, the Commissioners make what is known as a 'local inspection.' On arrival at a port they are

met by the Harbour Commissioners, or some representative. They then make a survey of the lights, buoys, perches, or other marks designed to facilitate the navigation. But such investigations are comparatively small affairs. The main object on the cruise is to visit the numerous establishments which are entirely under the control of our own board.

"Let me enumerate the different types of stations that we have to visit. They are all designed with the sole object of promoting the safety of navigation in the vicinity of our coasts. First of all we have the lighthouses, large and small, built on lonely islands or headlands, or rising, it may be, sheer out of the water. Of these there are many different types, adapted for various purposes. Then we have the lightships, which may be described as floating lighthouses. They mark dangerous rocks or shallow banks. Fog-signal arrangements are also to be found in all critical places round the coast. These vary in type from the old-fashioned cannon to the modern siren. It is the duty of the Committee to see that all these arrangements are kept up to the mark. They also visit the keepers' dwellings, investigate the boat arrangements for supplying the island stations with necessaries, and all other matters incidental to the service. Altogether the trip involves a visit to about a hundred establishments dotted round the coast. As the voyage seldom lasts for more than three weeks, the Inspecting Committee are at their labours early and late."

* * * * *

Thus ends my father's own account in so far as it was written in connected form.

He sometimes referred to his experiences with the Irish Lights Commissioners when on the platform. Here is a passage from his lecture, "How Came the Great Ice Age":

"It is a pleasant part of my duty to join the annual cruise of the Commissioners of Lighthouses round the coast of Ireland. Among the more remote places which we have an opportunity of visiting are the Isles of Arran, off Galway Bay. This desolate place is dear to the botanist, who remembers that it is the home in which the delicate maidenhair fern grows wild. To anyone who only knows this exquisite fern as we nurture it in our greenhouses, it will be a surprise to learn that its natural home is on a wilderness of barren rock. Yet so it is. This rock is limestone. It is deeply fissured, and

down in these fissures, under the influences of a genial clime, luxuriant vegetation springs up. There the maidenhair is to be found, and there I have often gathered it by stretching a long arm into the crevices.

"For our present purpose the special feature is not the limestone which forms the island, nor yet the maidenhair. It is this big stone to which I call attention. It is a piece of granite. There is no original granite naturally on the Isles of Arran. The nearest place where this kind of rock is met with is on the mainland, several miles away, between which and the Isles of Arran the deep Atlantic Ocean rolls its blue waves. It is perfectly certain that this block of granite—which is only one of many similar blocks strewn about the island—you can see another at the corner—has been broken away from its original home, has been transported across the sea, and has been deposited where we now find it.

"In ancient days there were great glaciers on the west coast of Ireland. They not only filled the mountain valleys, but they descended into the sea. They actually advanced into the Atlantic Ocean, and the ice was continuous from the Isles of Arran to the mountains where the granite is to be found. Thus were the great boulders conveyed to the sites where we now find them. They speak eloquently of the tremendous change which the climate has undergone in this part of the world."

When describing the effects of various kinds of "waves" in the lecture on "Invisible Stars" he had occasion to compare waves of light to the waves of the ocean:

"The wave is indeed a terrible engine of destruction. I have seen in the West of Ireland those mighty Cliffs of Moher, with which the Old World presents a stern but majestic front to the Atlantic. Those superb precipices, over which the eagle still soars, have been hewn out by the incessant blows of stately waves hurled from the broad ocean. In a lifetime—nay, even in the course of centuries—but little apparent progress is made in this colossal sculpture; but the invasion of the waves, if slow, is unremitting, and stupendous effects are produced when sufficient time is granted. In the lapse of geological periods of millions of years, the doom even of continents has been tolled by the everlasting thunder of the surf on the cliffs. By pondering on the awful efficacy of the

watery waves in battering down mountains, we shall perhaps be the more willing to credit the adequacy of the ethereal waves, even of invisible light, for the comparatively small task of inscribing their records on the photographic picture. It is, indeed, certain that when the astronomer exposes a plate for an hour or two to the heavens, the number of luminous waves of star light which break upon it are a hundred times more numerous than all the billows which the Atlantic has rolled in upon its shores, from the dawn of geological time down to the present hour."

In 1904 the *Princess Alexandra,* which had been in commission for a long time, was replaced by a more modern vessel called the *Alexandra.*

I remember asking the Scientific Adviser why the *Princess* was abandoned. He replied:

"A man was working in the hold one day, when he let his hammer drop, and it fell through the bottom of the ship!" And he added: "She was as leaky as a sprat net!"

Stories of courage and devotion to duty were sometimes told to the Commissioners on their tours of inspection, or recorded in their archives. My father preserved the following letter (dated July 27th, 1891) from the keeper on the Tuskar Rock, one of the most important lighthouses on the east coast. An assistant keeper had been seriously injured in an explosion:

"In reply to your letter of the 23rd inst. I beg to say that when I sent in my report of the accident, I had been twenty-four consecutive hours on duty, and was completely exhausted and unable to write a full account. I now, sir, send you an exact copy of the log kept at the station. There was a dense fog at the time of the accident, and it was J. M. Leary's watch, as he relieved me at 2 P.M., and the accident occurred at 2.30 P.M. at the gate at the N.E. corner of paint store. I asked him how it occurred, and he answered me twice, 'Putting in the detonators.' For further particulars see copy of log which was written at the time."

"*Copy of Log of July 20th,* 1891.

"At 2.30 P.M. during a dense fog J. M. Leary (Assistant Keeper) got most severely injured. He lost his right hand above the wrist, besides some severe cuts on the back of his head and neck, through the accidental bursting of a rocket while inserting the detonator into it. There was also injured at the same time (cut over left eye) J. Fortune, a boy of seven or eight years of

age, son of P. Fortune, lamp-trimmer. With the assistance of the carpenter and labourer working on the rock I bound up the wounds, and having stopped the flow of blood we got them carried to bed, P. Fortune at the same time keeping the fog-signal going, besides firing two shots every fifteen minutes in quick succession, for assistance. We hoisted our ensign (Union down), with the signal P.D. underneath, in hopes that it might be seen by some passing ship. At 4.30 P.M. a small Austrian steamer came off the west landing, but though we went down and pointed out the best place to land, I am of the opinion he considered the sea too heavy. Having hoisted his ensign at the foremast head, which I took to indicate that he had made out our signal, he disappeared in the fog, steering in a westerly direction. At 6.35 P.M., the fog having cleared a little, we saw the same steamer bearing down on the rock. When the steamer got off the N.E. landing, the captain signalled that he had forwarded our message. I signalled back 'Thanks.' The injured man getting weaker, I signalled to the steamer to send us a boat, but he steered N.E., taking no notice of our last signal. At 6.45 P.M. I observed a large steamer coming from the westward. As the evening looked bad, and there was no sign of assistance coming from land, I hoisted P.D. 'want immediate medical assistance.' The steamer, which proved to be the Cunard s.s. *Cephalonia*, stopped off the rock and lowered her lifeboat, in which the captain sent his doctor to our assistance. Having dressed the wounds, the doctor told me it would be best to take the injured man aboard, he being so weak it would be dangerous to leave him all night on the rock. I told Leary what the doctor suggested, and he said he was most anxious to go. We got him safely on board the ship's boat at 9.45 P.M., though there was a nasty sea running. I consider that great praise is due to the captain of the ship, also his doctor, chief officer, and crew for their gallant and humane conduct. As an instance of the sea that was running at the time, I omitted to mention that when within a few fathoms of the rock, the tiller struck the chief officer and knocked him overboard at the same time. It being dark at the time there was some trouble in picking him up again.

"In conclusion, I consider it my duty to mention that P. Fortune, lamp-trimmer, Phillip Duggan, a carpenter, and Thomas Ronan, labourer, gave all the assistance in their power, from the time of the accident until we got the injured man into the boat.

(Signed) "JOHN HAMILTON,
"Lightkeeper."

Whenever any unusual phenomena were observed on lonely rock or island, a report was forwarded to the Scientific

Adviser. On August 12th, 1887, he received the following, which had been addressed to the secretary to the Commissioners by the keeper on Green Island:

"I beg most respectfully to forward a report (as directed) of a strange and remarkable occurrence which took place here on the nights of March 1st and 2nd of this year, which I unintentionally omitted to bring under the notice of the Inspecting Committee.

"On the night of the 1st a peculiar form of fire or globular lightning was playing on the piles and handrail with a hissing noise.

"It first made its appearance about twelve feet down the handrail in a snow shower, with the wind varying from N.E. to E., and as it suddenly burst out on the handrail abreast of the door, I went in and did not watch it any longer.

"On the night of the 2nd it also came on with a snowstorm with the wind E.S.E., but this time it appeared to strike the top of the flue from the stove, part of it remaining there, but the greater portion of it flew to the perforated ball on the dome.

"It also burned very bright on the extreme points of the sections of the dome, with the same peculiar noise as before; even after daylight I could distinctly hear it, but could not see it.

"I respectfully beg to say that I made an entry of this in the lighthouse journal at the time, but did not think it necessary to report it as it did not do any damage."

My father invariably returned from a cruise well supplied with anecdotes. On one occasion he had been inspecting the Fastnet, one of the first lighthouses seen by the homeward-bound Atlantic liner. A new tower had just been completed, at the expenditure of much time and money, the work having been frequently interrupted by the raging of the elements, and he told us that whenever the workmen closed down for the day it was their practice to make everything trim. Nothing could be left loose on the rock, lest it should be washed away by the sea. When the lighthouse tower was nearing completion, a heavy box of tools was left on the platform under the lantern. Thinking it was out of reach of danger—the top of the tower is 150 feet above high-water mark—the workmen left the box unlashed. The sea rose in the night; and when day broke the box was gone!

In lighter vein he would speak of Tory Island—a place so

damp that, in the words of a local pundit, "all the snipes was dying of the rheumatics, and no human being could live in the place barring he was a seagull or a dispensary doctor!" He also brought back the following anecdote concerning an island on the west coast on which at one time there was no resident physician. A woman having been taken suddenly ill, a boat was dispatched to the mainland. The nearest doctor was summoned, but he refused to stir until his fee of £1 1s. was paid in advance. The money was found, and paid, to the accompaniment of many grumbles. Having seen and prescribed for his patient, the doctor essayed to return. He found the beach deserted. Finally, he asked the fishermen to row him back. The reply was: "Not a man on the island will take you back for less than a guinea!"

He also told of a man who, being about to set up house on one of the islands of the west, employed the local boatman to convey his furniture and effects from the mainland. When the boat, heavily laden, was approaching the jetty the following colloquy took place:

"Have you got it all there, Pat?"

"We have, yer honour."

"But where's the grand piano?"

"Shure, we're towing it behind!"

A safe(?) cure for a leaky boiler is prescribed in the following anecdote which he retailed after a cruise. In the neighbourhood of a lighthouse on the west coast the builder's men were at work. A steam crane was in operation. On looking at the boiler he noticed that a hole near its base was plugged with a piece of wood. Upon my father asking the crane driver whether it was not dangerous to use the boiler under such conditions, he replied: "Ah! It's all right, Sir Robert; the hole's well under wather. The steam's all at the top of the boiler!"

Other experiences with the Commissioners are recorded in the following letters:

To his wife (June 15th, 1900):

"In the hopes of being able to post this in Galway I write a few lines this morning. I am, as usual, the most sleepy head in the ship—the first to go to bed and the last to get up. But they are astir early here. Taking baths begins before seven, and this morning they were all off by eight to inspect Straw

Island Lighthouse, where, indeed, the rest of the party are at this moment. It is always understood that I go or don't go just as the humour suits me. No plans are ever made more than an hour or two in advance, as, of course, the weather decides everything. We are now in the Isles of Arran, and I am writing within sight of the arid-looking rocks where, in what seems at first sight the most unlikely of places, the maidenhair flourishes.

"We have the same old cook who has been with us, I believe, since I first went round; an old man with spectacles. He does things well according to his lights and resources, and we have the same dishes exactly year after year. You would enjoy the lobsters! They are, however, plain boiled, and when dished are not equal to yours! The consumption of them is vast. Someone said thunder was fatal to lobsters. This being doubted, I was referred to, and I said I thought lighthouse inspection was much more dangerous from the lobsters' point of view!

"Poor Douglas has quite broken down. It is a pity he could not see the completion of the Fastnet. They have been going ahead with that great work (you remember the stones at Penrhyn). On one fine day lately they put down twenty-seven!

"The good weather has left us for the present. Yesterday there was a bad roll on. We are generally tied up by the nose in harbour by dinner-time (eight). But yesterday this was not possible, and two of the party thought it would be safer for them not to come down.

"We are now just getting up the anchor. There are two other lights to be visited in the Arran Islands, and then we have a run of fifty miles to Galway. At Galway we shall stay to-morrow (Saturday), taking in coal, and we shall not leave until early on Monday morning. I don't think we much relish this part of the business, but some of them have their bicycles and look forward to a spin. Of course, there is the usual run of stories on board. Here is a specimen:

"'Carman (*loq.*): "Well, your honour, thim motor-cars will niver bate the horses! Sure, if they'd had motor-cars instead of horses in Maffykin, sorrow a mouthful would the poor soldgers have had to ate in the sage!"

"I have, of course, heard nothing of home news since I left. I am looking forward to getting a budget when we reach Galway this evening. There ought to be a big accumulation of letters there. The warm sea bath in the morning is glorious!"

To a friend (June 16th, 1900):

"I joined ship at Killybegs, and we have had a beautiful cruise so far. I greatly enjoyed it. (It is hard for me to write in this deck-house with such interruptions as the following: Riall (*loq.*): 'A housemaid at my father's gave notice of leaving

because the footman had called her a Kaffir.' 'Do you know what a Kaffir is?' asked Captain Riall. 'No, I don't, but I'm none o' them sort!' This led to many others, of course.) Captain Walker, son of the ex-Chancellor, is a recent addition to the party on board.

"We are now tied up in Galway Dock for coaling to-day, and for prayers to-morrow. A fleeting wish to be a cyclist has animated me this morning, for nine of the party are going off on a ride to Oughterard, or elsewhere. I shall work this morning, and go to see the salmon fishing, and call on the new President of the Queen's College this afternoon. The decay here is terrible, yet the inhabitants are such fine-looking people. I was greatly struck with them in the Isles of Arran yesterday, as I have often been before. The girls are so good-looking, clean and picturesque, and so modest that they will not look at you unless you address them, and then, in a sweet voice, comes: 'Good morning, kindly!'"

The Captain Riall referred to in the above letter was an old and dearly loved shipmate. He has been good enough to send me the following anecdote relating to the Scientific Adviser:

"There was a discussion at the Church Congress in Dublin pro and con. the Darwinian theory of Natural Selection. Dr. —— spoke against it, saying: 'Look, for instance, at the shark, a malignant monster with eyes on one side of his head and a mouth on the other. Under natural selection no such creature could exist.'

"Sir Robert, who subsequently took part in the discussion, said: 'While agreeing with some of the speaker's statements, I think that he is wrong in one respect. He does an injustice to the shark. I know him to be quite tender-hearted; but, like all other creatures, he requires food. Nature kindly steps in and places his eyes on one side of his head and his mouth on the other, so that he may not witness the struggles of his dying victims!'"

On one trip he wrote to his daughter (Mrs. Barcroft):

"*The Waves of the Atlantic, Longest Day*, 1900.

"I should so like to peep at you in your bridesmaid's costume at the wedding of your beloved friend. When I see your beautiful friendships (for such indeed they are) I am reminded of the words: 'Those friends thou hast and their adoption tried, grapple them to thyself with hoops of steel.' My blessings on

you this day and all days. I hope to be back in time to see Miss ——, or ——, or whatever I am to call her, but at the moment we are the plaything of the winds and waves. Having remained at anchor all yesterday, we started at four this morning and have been going ever since. Now we are on our way to the Skelligs.

"I had one nice flirtation with a dear little child of four at Galway, the grandchild of my old friend Professor Allman. Such a pretty little mite with a *black eye* which she got at the swing a couple of days before. She preferred sitting on my knee to going to her tea, and when she was induced to go, she was back again in no time, having only eaten *one* piece of bread and butter in contravention of all principles of nursery laws."

To his wife (June 22nd, 1903):

"The longest day was one of the loveliest days I ever saw. We spent it at the Arran Islands. We went to church in the most primitive manner, and then we had long walks through the maidenhair-bearing rocks to the famous Dun Angus. I got many 'snaps.' The people are wonderfully improved; they are all so clean and so picturesquely dressed and have such nice little children.

"But this morning the fine weather broke. We started at 4 A.M., and reached Loop Head at the entrance of the Shannon at 8 A.M. There we landed before breakfast, and it was, I think, the very nastiest landing I have ever seen. The sea was wildly dashing the boat at the foot of a cliff of most slippery ledges of rock, up which we had to scramble. They are all so kind and helpful to me that we got up all right, but the getting down was even worse. However, I was glad to show there was some life in me still.

"I got your budget at Tarbert, and the letters lie all round me on the table."

No part of the apparatus or appliances for lighthouses, lightships, etc., escaped his attention. Writing on "Waterloo Day," 1900, to his son Robert, he alluded to the economy of the oil engine which is used for compressing air at some stations, and continued:

"A nice application is to be found on the new lightship on the Coningbeg station. There is a very heavy cable and mooring anchor for a lightship which is difficult to raise under ordinary circumstances on the rare occasions when it is necessary to do so. A powerful steam winch is used for the purpose; but instead of using steam, the compressed air for the sirens is turned into the cylinders.

Scientific Adviser to Irish Lights Board

"We inspected a buoy yesterday which has a petroleum lamp which burns for a month in all weathers and under all circumstances. It also whistles by the undulations of the waves. The whistling is a very mournful sound, but they say it is effective, and I am told that the sea is hardly ever, or never, so calm that the whistle does not work."

His correspondent, Professor Charles Jasper Joly, the Irish Royal Astronomer, was not forgotten on these cruises. He wrote to him from Galway (July 16th, 1904):

"It seems a long time since I heard of you. I passed through Dublin on my way to join this cruise, but heard you were from home, so made no effort to get to Dunsink.

"I hope you will have some papers for the B.A. Do give us one on Quaternions. I would so like if some impetus could be given to the study of this subject.

"We have had a nice cruise from Kingstown round by the north in our new ship. About Eagle Island, off the corner of Donegal, we had the stiffest gale I ever remember on this coast. There was a tremendous sea, and we were glad to run in under the shelter of Achill Head.

"I send you a few 'snaps' I took last year. I got a good many pictures altogether, and I am trying this year to fill up some of the many *lacunæ*. There are many interesting optical problems in the lighthouse. The whole system is being revolutionised by floating the revolving apparatus in mercury. The friction is thus reduced to about the twentieth part of what it was before. A rapid rotation can be thus imparted even more easily than a slow rotation was possible before. The advantage which ensues in quickening the 'character' of the flash cannot be overestimated. Instead of having to wait minutes, the mariner is now able to identify the light he is looking at in the course of a few seconds."

On another occasion my father wrote:

"My thoughts for the last fortnight have been entirely on lighthouses and navigation, buoys and beacons. The trip is one full of interest and instruction in every way. The only reading I have done in any other direction has been on the subject of *earthquakes*. I have been studying Milne's book with great interest. From his observatory in the Isle of Wight he can detect *all* earthquakes, and he has introduced to science a new and very remarkable earth constant. It is the time that an earth tremor requires to travel across the earth's diameter. This is clearly a fundamental constant requiring most accurate determination. It is about twenty minutes. He shows that this points to the earth

as being twice as rigid as steel. I have been interested in the matter because I have promised to give a lecture on the Nebular Theory, which, of course, branches out into earthquakes as well as in many other directions."

To his sister, Mrs. Millington (July 9th, 1904):

"I get great amusement out of the camera, and a volume of my 'snaps' round the coast last year has been received with enthusiasm on board.

"*Sunday.*—Here we are lying at peace on a lovely day in Larne Harbour. Among our party is Scott, the engineer. He is a son of Archdeacon Scott, of Bray, and is a brilliant young fellow who has done splendid work already in the lighthouse service, and will do more. This annual trip with so many old friends has been one of the great enjoyments of my life. This year we have a new ship built for the purpose. They knew, of course, my habits by this time and that I spend many happy hours writing during the cruise. So I was a little touched by the chairman leading me up to the end of the saloon and showing me a writing table that had been specially bought for me (the captain was sent up to Dublin on purpose), with a sofa beside it on which I can take a nap whenever I feel inclined (and one does often feel so inclined at sea). I am in as great a condition of happiness as anyone has a right to be. Of course, I have my own snug little cabin as well, where I have most magnificent sleeps at night till roused to take my bath in lovely sea water made as hot as I like to take it, by steam. Then half a dozen times a day the gig puts off to take us to some lighthouse or lightship, and at night the ship is tied up by the nose in harbour. Then there is such a flood of talk of lights, and buoys, of sandbanks, shipwrecks, fog signals, projects for new lights or for the improvement of old lights! But it is not infrequently mixed with other topics, and I do love to meet a bright Irish party.

"I quite agree with you about liking to take 'people' in the landscapes. I always wait, if possible, to get a Commissioner or two or a boat or something or other. The interest of the pictures is immensely increased if a few portraits can be recognised.

"We had a 'bust up' in our domestic establishment on this ship! On the day we lay at Kingstown, and when fourteen were expected at dinner, the cook deserted! A new cook sent from Dublin has joined this morning."

As stated in the above letter, my father made extensive use of his camera on the voyages round the Irish coast. He gave a lecture at Cambridge illustrated by slides made from

LANDING AT THE FASTNET

THE LANDING-PLACE AT MINEHEAD

The oars of the Commissioners' boat are seen in the foreground

From photographs by Sir Robert Ball

his own photographs, and wrote the following account of it to a friend (November 20th, 1905):

"I had a show here the other day at the Antiquarian Society of the seventy slides that resulted from the last lighthouse trip. I did not call it a lecture, as it was merely an exhibition of the pictures with a suitable libretto. Many of them I had not seen before on the screen. The audience seemed very well satisfied, and indeed I must say they were exceedingly good. I first drew a sketch on the blackboard of the Skellig generally, showing the ancient steps; then I rubbed that out and I drew another picture showing the plan of the monastery, which I got out of Cook's book, as I think I told you; and then, having brought the audience into a proper frame of mind by reading bits from Miss Hull's book, and Miss Stokes' magnificent passage on the indescribable sadness of the spectacle, and having exhorted them that this was the appropriate frame of mind, provided that the sadness was of that species which was not 'akin to pain,' I took them step by step up the steps and showed them each of the objects on the plan. It did really well, though in the account I have just given I must say I have described rather what I now think I ought to have done than what I actually did do. For example, the sadness business only occurred to me last night. But the pictures are certainly very fine. If you ever care to have them for any show of yours I should be only too glad to lend them. The whole thing about these photographs is getting them developed properly."

The solicitude of the Commissioners for his comfort increased as the years advanced. This is reflected in the following letter to Mrs. Barcroft, written from Galway Bay (June 16th, 1910):

"I so often think of you and all your sweet love wherever I am, and certainly not least when I am on such a trip as the present.

"We are now among the Arran Islands, which means that half the journey is over. It is more delightful than ever. A more harmonious party could not exist. They are all so kind to me. They make everything so easy, and gently dissuade me from landing whenever there are any difficulties. But indeed the weather has been so lovely that so far the landings have been very easy. Even at Eagle Island the gig could be brought to the rock, and this *very* rarely happens in this wildest of wild spots.

"I would like to take Henry* over this ship and show him

* His grandson, Henry Barcroft, then *æt.* six.

how the leadsman sounds to show how deep it is. Give my love to him and Robbie, also to Joe and to Violet."

On June 9th, 1912, he wrote from Queenstown to his son Robert:

"Many thanks for your letter. I was so glad to hear of the pretty celebration of Stella's birthday. We made a dash over to Fishguard. It is a fine harbour carved out of the side of a hill, and seems full of life and business. We had to take on board a cargo of guncotton, cartridges, and other combustibles for the fog-signal stations. The weather has been excellent. We are spending Sunday here. I have been taking things very quietly. I go ashore very little, but I greatly enjoyed trips in the steam launch up the river at Wexford and Dungarvon. Yesterday we went up to Cork in the *Alexandra*. There is very little traffic in Queenstown now; not a vessel lying at anchor, and the inward liners are ceasing to call. They either go on to Fishguard or straight to Liverpool. The trip has done me much good already. They are all very kind and thoughtful. Love to Olga and the chicks."

I have mentioned that my father always took Bentham's "British Flora" with him when on these cruises. It must be remembered that he was the son of a botanist, and that he inherited a love of botany. He was not one of your modern students, who is mainly concerned with the internal structure of plants. He was a botanist of the old school. In some respects his knowledge was amazing. On a country walk in springtime or early summer it was difficult to find a flowering plant which he could not name in English and in Latin. He could tell his companion where he had seen that plant before; how he had found it nestling in the crevices of rock on the Hill of Howth, or under the trees of the Dargle, or beneath the shadow of the Great Sugar Loaf. His wide knowledge of this fascinating department in botany stands well revealed in the pages of his "Bentham."

In his copy of that excellent work, which he had had specially interleaved, he was wont to record the place at which he found any particular plant. It became in course of time what a lawyer would term a "noted-up" edition. Some of the entries were made as early as the year 1866. How he loved and treasured that book—his constant companion on every holiday—with its broken cover and thumb-marked pages!

Scientific Adviser to Irish Lights Board

I have examined this volume (which is now in the possession of Sir Charles Ball) with a view to seeing whether it contained any entries of particular interest. With one exception his memoranda relate merely to the places where, and times at which, various plants were found. The exception, however, is notable. It seems that his love of botany caused the astronomer to turn poet, and his effort was here recorded. He had found a plant named *Elecampane* amongst the ruins of an ancient monastery on Church Island, Waterville, Co. Kerry, a place which he often visited when cruising with the Commissioners. This plant is not indigenous, but is reported to have been cultivated in days gone by by the monks, who used a decoction of the leaves medicinally:

ELECAMPANE

On an island in Waterville's exquisite lake,
Which mountains encompass with heather and brake,
St. Finan resolved he would watch and would pray
In the bleak winter night and the bright summer day.

He built him a cell from the rude stones around,
He erected a shrine which is still to be found;
He knelt and he chanted both early and late,
And daily his orisons reached heaven's gate.

He planted a garden in which he could grow
The food which sufficed for his life here below;
His fastings were oft, and his diet was spare,
So his labour produced all he needed as fare.

As a part of the penance his goodness to test
Dire bodily ailment most bitterly pressed;
So he planted a simple which banished the pain—
That simple was only the Elecampane.

He blessèd that herb which his good life preserved,
And then waxèd great with renown well-deserved.
Monks flocked to Lough Currane from France and from Spain,
And settled where flourished the Elecampane.

That shrine on the island, with sanctity blessed,
For hundreds of years was the home of the best;
The abbey increased, and come sun or come rain,
In the garden still flourished the Elecampane.

That church had its day, and at last change began;
The monks went elsewhere as the course of time ran;
The abbey was silent, then ruins became,
But verdant as ever grew Elecampane.

Again many hundreds of years have gone by,
And most of the abbey does now prostrate lie;
Inscriptions and carvings still point out its fane,
And bright 'mid the ruins blows Elecampane.

Though the tomb of the saint is a thousand years old,
His spirit, we know, is in raptures untold,
And his mouldering shrine—may it ever sustain
The life of the beautiful Elecampane.

ROBERT S. BALL.

Waterville House,
Co. Kerry.
August 18th, 1905.

CHAPTER XII

LATER ASSOCIATION WITH TRINITY COLLEGE, DUBLIN

ALTHOUGH the last twenty-one years of my father's life were spent at Cambridge, he never wavered in his loyalty to his *Alma Mater*. He had given her of his best for many years, and while he was resident in Cambridge he never lost an opportunity of helping his old University. He was in frequent correspondence with her professors, and when he visited his native city seldom failed to spend some time within the portals of the beloved college. Nor was he forgotten by those of his old University. It is now an open secret that he was frequently consulted when there were professorial chairs to be filled; his ripe judgment and wide acquaintance among scientific men were of the utmost value to the Board of Trinity College when they were called upon to make educational appointments. It would not be difficult to set down the names of several men still living who ascribe much of their material advancement to his kindly influence.

His connection with Trinity College and Trinity men was also kept up through the medium of the Trinity College Dining Club, an institution founded for the purpose of bringing together past and present members of the college. They dine together once a year in London. Not only was he a constant and welcome member of the company on these occasions, but he was undoubtedly a "draw." Mr. Richard Ringwood, who has been secretary of the club for twenty-two years, wrote to me as follows on May 21st, 1914:

"I do not think I had any correspondence with your father beyond letters relative to our 'T.C.D.' dinners, which he was always delighted to attend when he could. But as hon. secretary for twenty-two years I may tell you that there was no more popular man in the club. Over and over again (when my circular had gone out) I have been asked: 'Is Ball coming?' 'Is he going to speak?' If he was, a ticket would

be taken at once. When your father spoke we all thoroughly enjoyed his playful allusions to Salmon, Traill, Mahaffy, Gray, and other T.C.D. celebrities well known to us graduates, and though we were dining in London we really felt that we were back in college. By the way, the impression which your father always left on my mind, rightly or wrongly, was that though he was a distinguished professor at Cambridge, living among English people, he remained Irish to the end, in his thoughts and affections, and in his manner and his love for his native country."

I have found amongst my father's papers fairly complete notes of some of the speeches which he made at these gatherings. On May 9th, 1894, he proposed the toast, "Success to the University of Dublin." Mr. Justice Henn Collins, who subsequently became Master of the Rolls, and finally Lord Collins, was in the chair. In the course of his speech my father said:

"Happy indeed is the college who possesses as its titular head a man who stands forth as an intellectual giant in the estimation of the world. Happy indeed is that University which has in its Provost a man whose extraordinary gifts are fitly accompanied by such graces as those which make the name of George Salmon dear to every graduate of our University. It has been indeed unfair to the human race that the goodness and the brains which would suffice to stock an ordinary college, have been in the case of Salmon concentrated into one individual. As a general rule I don't believe in the possession of universal knowledge. The claims made by Salmon's friends are much more moderate. We don't say he has universal knowledge; there are, I think, not more than half a dozen subjects in which Dr. Salmon is absolutely superior to every other human being at the present time; not that I intend to put any bound to his capabilities. A friend of mine—a very distinguished professor in our University—when he saw with what admirable skill and efficiency Dr. Salmon threw himself into the duties of a ceremonial character in connection with the Tercentenary Celebrations, made a remarkable pronouncement:

"'I declare,' said he, 'anything the Provost tries to do he does better than any other man in the kingdom. I verily believe that if Dr. Salmon were to take it into his head that to teach dancing was a part of the duty of the Provost of Trinity College, Dublin, such an accomplished master of the terpsichorean art would never before have guided the steps of the learners!'

"Dr. Salmon writes about Conic Sections—and his work has

been a quarry in which all other writers at home and abroad have ever since mined without even yet exhausting its resources. Dr. Salmon lays aside his mathematics, says he has forgotten all about them, and turns to theology—forthwith all other theologians in the kingdom take a back seat. His books on theology are not only profound, but they are actually amusing; jokes—aye, and excellent jokes, too—are to be found in volumes which no ecclesiastical library, from that of the Archbishop of Canterbury down to that of the rawest curate, can possibly be without.

"Dr. Salmon retired from playing chess for the simple reason that he had no one else to beat.

"I remember well the first speech he made. It was not a great success; and now, as everybody knows, there is no pulpit orator more effective, there is no voice on the platform which speaks with a more genuine and a more telling eloquence.

"And yet, if I were asked what the most remarkable characteristics of our dear Provost are, I think I should say his gentle simplicity, his unaffected kindliness, and his exquisite sympathy. He has 'a heart for friendship formed,' and to own that friendship is one of the privileges which an association with our dear old University enables us to enjoy.

"I hardly like to trust myself to speak in detail of the present members of the staff of Trinity College, Dublin. They are all of them well known to most of us. I am proud to think that many of them are my very warm personal friends; but on an occasion of this sort we are bound to set forth the claims of our University to the intellectual respect of the world.

"There has been no greater source of pride to every lover of our *Alma Mater* than to watch the gradual development of that school of classical learning for which Trinity College, Dublin, is now so famous. I have no knowledge, I am sorry to say, of such matters personally. But I know the common repute in which our classical workers are held; I know that in no universities in the kingdom, or out of it, are two classical professors spoken of with greater respect than Professor Tyrrell and Professor Palmer.

"And now we discern a school of history arising in Trinity College, Dublin, and the name of Bury, young though Bury is, has already taken its place among the very foremost ranks of historians.

"In science, also, Trinity College is ever in the van. It has taken a generation or two to begin to realise the stupendous scientific achievements of William Rowan Hamilton, and many generations will probably have yet to elapse before the world is fully aware of that stupendous intellectual effort known as 'The Theory of Quaternions.' Professor Tait, a Scotsman, accus-

tomed to weigh his words, and probably the only man in the kingdom fully qualified to pronounce on the matter, has deliberately laid it down that Napoleon and William Rowan Hamilton are the two most remarkable individuals of modern times.

"It was only the other day that I read a paper by a distinguished Cambridge professor in which he once again said that Macullagh's treatment of the great problem of light was unquestionably the greatest advance that has ever been made in the theoretical branches of that subject.

"And the mathematical repute given to our University by the giants of the past is upheld to-day. I find everywhere that when a man wants to know his differential calculus, it is to Williamson that he goes. If he wants to know how to solve an equation, he looks up his 'Burnside and Panton.' If he has to face the arduous problems of mechanics, he gets his best help from Minchin or from Tarleton.

"In physics also the University of Dublin maintains its worthy repute. There is no name more fit to conjure by in all matters where the profoundest knowledge of light and heat or electricity is concerned than the name of George Francis FitzGerald. With an instinct that seems almost miraculous, FitzGerald has the power of taking in the subtlest operations of Nature. Often and often have I heard FitzGerald's opinion on the very deepest questions of physics quoted as final authority in the matter.

"But the time would fail me were I to attempt to tell of all the other labours that have come from the Fellows and Professors of Trinity College, Dublin.

"Unbounded sorrow was felt in Ireland at the death of Sir Robert Stewart. It was realised that one of the greatest musical geniuses of modern times had passed away.

"Nor can I talk of Abbott's learned disquisitions on all subjects from the 'Tides' to the *Codex Sinaiticus*, of Professor Atkinson's philological studies—or of his recreations, which include learning a new language every six months!

"Time would fail me to tell of all the books with which Mahaffy has charmed and delighted so many readers, as it would to enumerate the various books and treatises with which Dr. Haughton has illustrated his many-sided sympathies."

He took the chair at the dinner on May 8th, 1895. In the course of his speech he said:

"We remember how, on that awful day of entrance, we crept up to our tutor's rooms at half-past eight, and with a few other timid youths tapped gently at the door, to be admitted to that dreary festivity known as the 'Entrance Break-

fast.' I believe we all had much better appetites for our dinner in the evening than we had for the 'Sally Lunns' at that solemn function! How we trembled at the advice of the tutor as to how we were to comport ourselves! How gratified we felt at his cheerful assurance that, bad as we might think ourselves, it was highly probable that there might be others in the hall who were even worse. My mind received on that day a photographic impression of the Hall Porter which it has never lost. Even to this day I regard that man with a degree of respect which I have never been able to accord even to a Cabinet Minister. Those were, indeed, the days when we did feel reverence! You all remember how you looked upon a man who had just taken his degree with more profound admiration and respect than any human being has ever received from you since!

"Then, too, in the hall on that fateful day, what supreme moments of anxiety! You will remember the awful period of suspense before you knew whether for the Latin composition paper you had got a '2,' or whether you had risen to the heights of a '3.' You remember how you fruitlessly gazed for inspiration on the marble angels round the hall. You remember your anxieties as to the extent to which dear old Dick Townsend (peace be to his ashes!) would be successful in cajoling the Senior Lecturer to relax his rules in your interest. You will remember how you thought your supremest moment had come when you rose from your seats at the entrance of the Provost.

"You will remember how you compared notes as to the temper of this examiner, and how you walked into the traps set for you by that! You will remember the moments of delirious rapture when the Bursar condescended to accept your £15, and how you walked on air from the gates of the college up Dame Street, and felt that you too belonged to that great institution—T.C.D.! You, my friends, have had many successes in after life, but I ask you—did any success ever equal the pride and delight with which affectionate parents and sisters rushed out to greet you at the door, when you told them that you—yes, you—were a member of Trinity College, Dublin?

"I remember the first debate I ever heard at the 'Historical.' The Society was addressed by two young fellows named Lecky and Plunkett.* The world now knows who those two young fellows were!

"A notable example of the grit of T.C.D. men was provided the other day. We have always had a friendly and

* Now Lord Rathmore.

sympathetic feeling for the Queen's Colleges, and we wish them and their graduates every prosperity. But an illustration of what can be done is provided in the case of President Moffat, the distinguished scholar who has presided over the Galway College so long and so ably. The authorities thought that it was time for him to retire owing to advancing years. But the gallant President did not agree with them. They went as far as to dismiss him, but still he would not go. At last they sought an interview. The result was that he was reinstated, and a remarkable scene, unparalleled in the sober history of the Queen's College, took place. The students and the whole town of Galway turned out to welcome the return of their venerated President! Long may he live to preside over the institution whose dignity he has so splendidly vindicated."

Sir Robert was present again at the dinner in 1901, when Lord Macnaghten was in the chair. On this occasion he had something to say about college finance:

"The splendid success of T.C.D. is due to many causes. It is due to the admirable material on which it has to work; and it is due to the sound commonsense principles on which it is worked.

"Let me illustrate this. In other establishments prudent finance has gone to the four winds of heaven. Is there now any institution with a penny piece in its coffers? Certainly the British Exchequer is not one of them. And why? Simply because they have forgotten the good old fundamental principle that it is a fatal mistake to publish a balance-sheet! Nobody would be left with a sixpence if he proclaimed to the world all he had. The sixpence would be seized the moment he admitted its possession! Trinity College has avoided all that nonsense. They never divulge their accounts. They put their affairs into the hands of a highly capable and trustworthy Bursar, who is one of their own body, and they bid him manage their affairs. He does manage them, and manages them well.

"Let a Fellow or Professor come to the Bursar of T.C.D. with some pet fad in which the Bursar does not believe, and try to wheedle some money out of him! Much chance he has! The Bursar is civil; he even appears to be sympathetic. 'But, my dear fellow,' I can hear him say, 'I assure you our affairs are greatly straitened,' etc., and the applicant is gently but effectively repulsed. But when some really important matter affecting the welfare or dignity of the college is involved the finances take an extraordinary turn for the better, and a stately building or a new Chair is founded! That is what I call good financial management, but it is wholly incompatible with

that ridiculous pandering to impertinent curiosity involved in the publication of a balance-sheet.

"I was for eighteen years a professor in T.C.D., and I had experience of bursars in both these moods. More than half that time my dear old friend, and a dear old friend of many present, the late Rev. Dr. Stubbs, was Bursar. When I had left T.C.D. and came to Cambridge I maintained an affection for Dr. Stubbs to the last day of his life.

"One day I said to him: 'Dr. Stubbs, I am no longer Professor; you are no longer Bursar. There need be no humbug between us any longer; you can have no possible object in humbugging me now. Do tell me what you raised for the college during the thirteen years you were Bursar?' He immediately pulled out his pocket-book, on a page of which the figures I wanted were clearly written. He had indeed been a faithful steward. He had raised for the college either in fixed capital or in cash the sum of no less than—— Well, no! I will not tell you the exact sum. I will not give away the college affairs.

"The Board that rules the college is the same as it was the last time we met here. The Board often has its difficulties. It has its difficulties like the rest of us. But it has ruled T.C.D., and the success of T.C.D.—the great success of T.C.D.—is a proof that the rule of the Board, although it is not quite so swift to adopt reform as some of its more precipitate advisers would like, has been a wise and beneficent rule, and has been of infinite advantage to the university.

"And now I have done. I thank you all for the heartiness with which you have welcomed the toast of the T.C.D. I know there are many things I have left out. I have left unsaid the things I ought to have said, but I am naturally consoled by the reflection that I have said the things which I ought not to have said. I resume my seat with the same feeling as that of an eminent counsel who at the end of his career was asked if he did not feel disturbed at the thought that by his skilful advocacy criminals had escaped justice. 'No,' he said, 'that does not oppress me. It is counterbalanced by the reflection that I have sent so many innocent men to the gallows that, on the average, justice has been done.'"

On another of these occasions he alluded to degrees for women. Having pointed out that T.C.D. was the first of the old universities to "remove the barriers" and grant degrees, he continued:

"But the removal of the barriers does not immediately produce the desired result. At the Zoo the old bars of the

lion's cage, which would have kept in a locomotive, were replaced by lighter ones. The public were quite satisfied; but the lions were found cowering in the corners with timidity. They thought the bars were to keep the public from attacking them!"

Of the late Sir David Gill, who was a guest at one of the T.C.D. dinners, my father said:

"He is one of my oldest friends. He is the most distinguished practical British astronomer since Bradley who has presided over one of our national observatories. As Royal Astronomer at the Cape of Good Hope, he has made discoveries more valuable than all the treasures of the Rand. He now draws near to the close of his service. We give to him the heartiest of welcomes, not so much for his practical services, not so much for his great discoveries; we welcome him as one who, with the purest and most single-minded purpose, has devoted himself to the search after truth."

Sir Robert was ever ready to come forward in the interests of his old University when her privileges were threatened. The establishment of the old National University of Ireland has rendered Trinity College secure, but in 1907 her interests were thought to be menaced by Mr. Bryce's previous scheme. A meeting of protest was assembled at the Middle Temple Hall on Monday, March 25th, under the presidency of Lord Rathmore, when Sir Robert proposed the following resolution, which was carried unanimously:

"That this meeting protests against any legislation which would transform the University of Dublin into a university comprising colleges identified with different religious denominations and animated by conflicting educational ideals; and, further, records its belief that such change would introduce sectarian division into the administration of the University, and subject teaching and research to limitations injurious to liberal education and free inquiry.

"This protest is made not on political grounds, but solely in the interests of liberal education."

His later association with Trinity College is also reflected in his letters. In June, 1900, the Provost (Dr. Salmon) had

invited him to be present at a Scholars' dinner. Sir Robert having accepted, the Provost wrote as follows:

"I am glad you are coming to our Scholars' dinner, where I have no doubt you will meet many old friends. As we do not go in largely for oratory I have no chance of getting a speech out of you, and I fear that on that evening I can hope to see little of you. Your brother Charles tells me that he expects you to arrive on Friday. So I have asked him to bring you with him to a quiet dinner on the Saturday. Possibly I may have two or three others of our guests who will have come over in anticipation. At all events, I shall have no difficulty in making up a little party of your old friends."

Here is a letter from the Provost, to whom he had sent a copy of the "Theory of Screws":

"I think I told you how many weeks I have had of very poor health. It was a surprise to me this morning in attempting to clear my table to find among the contents a presentation copy of your 'Theory of Screws,' which I have no recollection of having received, though the book has been taken out of its wrappings and laid on my table.

"The unconscious self who acts for me has of very late years extended his province most unrighteously, and so often omits to tell me of his doings that I spend half my time in looking for things he has hid away! I cannot, therefore, venture to say that I did not know of the arrival of your present, and though it would surprise me very much if you were to tell me that I had at the time written to thank you for it, yet other things that have occurred would forbid my being absolutely incredulous. But as to the best of my belief I made no acknowledgment, let me do so now. I am by no means so worthy of your gift as I might have been a few years ago, and my reading of the work is likely to be superficial. But this morning I received from the Cambridge University Press a second volume of Adams's memoirs, and though I am likely to read less of them than of your work, yet from my regard for the man the gift has given me great pleasure; and your gift gives me pleasure of the same kind. My conscience smites me, as I ought not to have been deterred from sending you a copy of my sermons by the unlikelihood that you would care to read any of them. I send a copy now, and, after all, I dare say you will like to read what I say about Adams (page 18).

"I also omitted to thank your daughter and you for the new photograph, which, if I were to follow King Hiram's bad example of looking a gift horse in the mouth (1 Kings ix., 12, 13),

I should call 'Cabul' as not being a 'pleasing' likeness. However, I shall not be filling the new photo book until after the Long Vacation, and I shall then have to consider whether you will be more truthfully represented to posterity by an agreeable likeness even in bad condition than by a very grave and serious one in good preservation."

In January, 1904, certain letters passed between him and Professor Joly, who had suggested an alteration in the method of awarding Fellowships in Trinity College. They were then (as they are still) awarded by competitive examination. Professor Joly (whose letter is not before me) had apparently suggested that the dissertation system which is in vogue at Cambridge should be adopted in Dublin. Sir Robert wrote in reply:

"If I have not answered your letter on the important Fellowship question before, it is not because I am indifferent but rather because of the great difficulty of the problem. There is also another personal point which I may illustrate by the ever sagacious Provost. When Cayley died, the Electing Board, who were to appoint his successor, referred the matter to Darwin and me as a Committee to advise our colleagues as to the man to be chosen. It was agreed between us that I was to seek advice from Klein and Salmon, of course in the most private manner. Klein wrote a characteristic letter and a very serviceable one. Salmon said it would be utterly wrong for an official in one University to offer advice to another University on such a matter, and Cathcart said he thought this was the sound view. The upshot was that Forsyth was appointed.

"I don't say that this case is analogous to the present one, but I do feel there is something in Salmon's argument, and so, as a Cambridge professor, I feel a little shy in discussing the matter, perhaps the more so because I was not a very successful Fellowship candidate myself!

"After this exordium you will, I fear, be greatly disappointed at the beggarly paucity of my thoughts, but I will set them down such as they are.

"I quite see what you say as to the risk peculiar to Ireland of a religious row arising out of the presentation of original essays by two different men on different subjects, if one of these men went to Mass and the other to church, and if the election to the fellowship depended on the relative merit of the essays.

"But in the present system is there not also a risk of the same kind? Suppose an R.C. was purely a classic and an Orangeman a mathematician. They would be competing on lines so totally

different that there would be the makings of a nice religious fight if the Orangeman got in.

"I like your scheme about the readers, but here is the difficulty. How can you guarantee that classes will be obtained to listen to these lectures? Over here I know this would occur to everybody as a difficulty. I know a man here, a Fellow in Trinity, who is, I believe, a very able man. His lectures are attended by a class of two, of whom one is his wife! There are many of us here who are glad to get even two in a class (Cayley, however, told me that he regarded two as the irreducible minimum), and unless in the popular subjects or compulsory tutorial lectures, a class of half a dozen is considered extremely good. Suppose you had a clever young reader—a future FitzGerald—who would lecture, say, on 'An Electrodynamical Theory of Spiral Nebulæ' (this is actually a course announced here by Whittaker), would he get a class? Perhaps, however, it is intended that as a reader he should give a set of tutorial and elementary lectures. But, then, that hardly gives a promising man of science an opportunity for distinction. And after all, is the capacity to teach an elementary class a very useful test? I have heard that rumour says even FitzGerald himself would not have scored *very* high in that particular.

"I am afraid it would be very difficult to carry through a scheme like that you have sketched. I think the religious difficulty might also arise in estimating the merits of the reader. Indeed, the risk of the religious difficulty must be faced in every scheme.

"Mathematical Fellows here of the best type are Smith's Prizemen or runners up; and the Fellowship is decided on the Tripos and an essay, which essay not infrequently is the Smith's Prize essay (for, as you know, the Smith's Prize is awarded solely for an essay).

"Would it not be possible to leave the Fellowship examination as it is at present, but to allow half-marks in each subject for an original piece of work, in MS. or print? The difficulty of studying the essay is an onerous matter for the examiners.

"I wish I could have rendered you more service, or, indeed, any at all. I have lots more to say on other subjects, but it is 1 A.M.!"

Professor Joly wrote a reply, in the course of which he said:

"In spite of your modesty, I may tell you that one of the strongest arguments with a good many men in favour of a change is the fact that you did not get a Fellowship!"

CHAPTER XIII

THE DUBLIN ZOO

THE reader who has not skipped the first chapter of this volume will remember that my grandfather, Dr. Robert Ball, was intimately connected with the Royal Zoological Society of Ireland. My father inherited a love of animals, and throughout his life took a lively interest in the Society.

Sir Robert's earliest recollection was an incident of a zoological character. I found the following memorandum amongst the notes which he had prepared for a chapter on "The Zoo":

"The giraffe arrived in Dublin on June 19th, 1844. I remember this quite well, although I was only four years old at the time."

His connection with the Dublin Zoo may be thus briefly recorded: He became a member in 1861. In January, 1869, he was elected to the Council, and from that time on, he took an active share in the affairs of the Society. When Astronomer Royal for Ireland, he made a point of attending the Saturday morning breakfasts at the Gardens, greatly enjoying the walk from Dunsink across the Phœnix Park. After the "high" bicycle came into general use, but before the "safety" was invented, he used to ride to the Gardens on a peculiar machine known as the "Facile"—by no means an easy method of locomotion when judged by modern standards.

How his services were appreciated is shown by the Society's action in 1890. On December 21st, 1889, he received the following letter from his brother, Professor Valentine Ball, C.B., F.R.S., who was then the Secretary of the Society:

"Haughton's five years as President are up, and under the rules he cannot be re-elected. A strong opinion was expressed that you should be elected, but after a statement by me it was decided to defer election till I had communicated with you. I told them of our conversation, but they were resolute to have you. What do you think?"

A desire so strongly expressed by the Council could not be withstood, and he was elected President of the Society in January, 1890, for a period of five years, in succession to the Rev. Dr. Haughton.

His Cambridge appointment, however, rendered it necessary for him to resign before he had served the full term. At a meeting of the Council on March 5th, 1892, the following resolution was proposed by Mr. Hogg, seconded by Mr. Findlater, and passed unanimously:

"The Council of the R.Z.S.I., while congratulating the University of Cambridge on having secured for the Lowndean Chair of Astronomy so illustrious an Irishman as Sir Robert Ball, F.R.S., Astronomer Royal of Ireland and President of the R.Z.S.I., beg to convey to him this expression of their sincere regret at his departure from Ireland, and their sense of the loss sustained by the Society in consequence."

A further step taken by the Council to show their appreciation of his services is thus recorded in my father's own words:

"Before I left Dublin for Cambridge the Council of the Royal Zoological Society entertained me at a dinner at the Royal Marine Hotel, Kingstown, on June 1st, 1892. Dr. Traill, subsequently Provost of Trinity College, presided. Among the speakers were my valued friends Dr. Salmon, then Provost, Dr. Mahaffy, Dr. Ingram, my old tutor, then President of the Royal Irish Academy, Mr. Justice Munro, and the Lord Mayor. I had to propose the health of the Council of the Royal Zoological Society, and perhaps I may be permitted to set down a few sentences of what I said:

"'As I look over the list of the Council, there is hardly a name in it which is not full of pleasant associations and of old ties of friendship in connection with useful and delightful work. My obligations to the Council are far too numerous to specify, but there is one to which it will be impossible not to refer. It is now thirty-five years since the death of my father, a devoted Secretary of the Society. My mother and her family found in the Council and the members of the Royal Zoological Society a host of friends who, at a very critical period, rendered assistance of the most substantial and valuable description. My brothers and I have never forgotten this, and we never

shall. Among those members of the Society who then came forward in this spontaneous and generous manner I am glad to see two here present to-night. I refer to my very old and valued friends Maxwell Hutton and Perceval Wright. United as I am to the Council of the Zoological Society by bonds so old, so dear, and so intimate, is it any wonder that I am speaking with all my heart when I give you the toast of "The Council of the Royal Zoological Society of Ireland"?'"

Many were the stories which he used to tell of the Zoological Gardens. He always said that there was no form of business transaction so uncertain as the sale or purchase of a wild animal. In the numerous encounters which they had with the animal dealers the Council often came off second best. He told of a bear which never left its cage "even when the door was open," for the all-sufficient reason that it suffered from spinal paralysis at and since the time of purchase! A letter written on October 24th, 1899, to Dr. Cunningham, Professor of Anatomy in the University of Dublin and Secretary of the Zoo, which is preserved in the archives of the Society, is of interest in this connection. It should be mentioned that Cullen, who is referred to, was a factotum in the house at Granby Row, Dublin, where my father spent his childhood:

"On looking over some letters the other day in search of an autograph of my father, I came on one which will, I think, interest you. I will show you the original sometime, but cannot resist sending you an extract. Please observe that the date of the letter is June 18th, 1847. It was addressed by 'Robert Ball,' Secretary of the Society, to his son 'Robert S. Ball,' then six years old, and it refers to my brother Val, then three years old. The extract is as follows:

"'I bought to-day a sloth for £15. I am afraid it is a bad bargain, as he has a cold, and is sick already. I also bought a great snake nine feet long. He was very weak, so Cullen got a jug full of calf's blood and we poured it down its throat. Val was not a bit afraid either of the snake or the sloth.'

"This letter is, I think, worthy of your attention, inasmuch as it is a communication from the existing Secretary to a future President. It also contains an important reference to a future Secretary. You will observe that my brother Val, even at the age of three, displayed that intrepidity in the presence of wild beasts which he showed in the slaughter of ferocious animals in India, and in the management of the Zoo! You will also note the valuable prescription for a sick snake, though unfortunately

the result of the heroic remedy is not recorded. I can well imagine the scene, with Cullen and my father pouring the blood down the snake's throat in our back kitchen. I also call to mind the look of saintly resignation on the face of our old cook at seeing her sanctuary made the scene of an operation so remarkable. But the principal point involved in this interesting letter is that not only was the snake a sickly one, but the sloth had a latent, and we have only too good reason to believe, a mortal cold at the time of purchase! You will note that even in those days the Secretary was 'had' by the animal dealers!"

It may be mentioned—in order to show that the family of Ball is still closely connected with the Dublin Zoo—that Sir Charles Ball, Bart., has been President since 1909.

Other than financial difficulty sometimes attended the purchase of animals. Sir Robert wrote as follows in his "Zoo notes": "It was part of the duty of the Secretary to buy such animals as might come into the market from time to time. Occasionally he was sent to examine the beasts for sale on the premises of the dealer. On one occasion the Secretary had been on an expedition of this kind, and he recounted his adventures at the breakfast on the following Saturday morning. His report was something like this: 'I heard,' he said, 'that Mr. (naming a dealer then well known) had a fine baboon for sale, and upon writing to ascertain the price, he invited me to come and inspect it. I had never been to his place before, and rather expected to see a miniature Zoological Gardens. To my surprise I found the collection of animals was kept in what was little better than an ordinary house. Every nook and cranny in every room from basement to roof seemed to be full of cages containing every imaginable kind of bird and beast. A giraffe occupied a room on the ground floor, there being a hole in the ceiling through which he could extend his long neck to its full height! As I passed up a narrow staircase to the upper story various beasts made grabs at me through the bars of cages fastened to the walls, so that I had to keep on the banister side of the stairs as far as possible. When we reached the top floor the proprietor opened the door of a garret, announcing that the baboon I had come to see was kept there in a cage by itself. We entered the room. True, the great beast was in a cage, but it was so much out of repair that I felt rather nervous. My apprehension was in-

creased when the animal, maddened by what he evidently considered an intrusion on his privacy, made wild endeavours to escape. He shook the bars with all his might. Finally he did manage to break through one side of the cage. Instantly my companion rushed through the door, shut it behind him with a bang, and left me face to face with the largest and most terrific baboon I had ever seen. "Let me out! Let me out!" I cried, banging on the door of the apartment. "I daren't," was the reply. "If that brute gets out he is certain to kill somebody!"' That is the Secretary's story so far as I can remember it. Whether the baboon was purchased ultimately by the Zoo I do not know."

In 1899 Sir Robert was invited to speak at the opening of the Haughton House, which now adorns the Gardens. Dr. Cunningham, in sending the invitation, wrote:

"There will not be much speaking; in fact, only yourself and the Lord-Lieutenant. Of course, your part would be to say something of Haughton, and of the motives which actuated us in raising the memorial. I realise that this is a very great favour to ask you, but you know how the Council feel towards you, and how they would not consider the function complete without your presence."

It should be mentioned in connection with the address delivered on this occasion that Dr. Haughton had been joint Secretary of the Gardens with Professor M'Dowel from 1862 to 1863, and Secretary from 1868 to 1884. He had been President from 1885 to 1889. Throughout this period he was the guide, philosopher and friend of the Council, and the best animal physician it was possible to procure.

On a lovely day in May, 1899, to a distinguished gathering which included the Lord-Lieutenant and the late Lord Roberts of Kandahar, who was then President of the Society, Sir Robert spoke as follows:

"My first words must express to your Excellency the gratitude of the members of the Royal Zoological Society of Ireland for the honour of your presence on this memorable occasion. I can assure you that I use these words in no mere conventional sense. The many valued old friends of the Gardens assembled in this room know how sincerely many of us are attached to this institution. I may, for example, be permitted to say that my own interest in the Gardens began with my earliest years.

The Dublin Zoo

Almost every animal that has occupied our cages for, shall I say, forty years, has been familiar to me. Indeed, since the lamented death of that friend of my youth, poor old Jack, the pelican, who perambulated these Gardens for nine-and-thirty years, I have always considered myself the oldest animal in the Society's collection!

"I think everyone who has enjoyed the privilege—and it is a high privilege, an intellectual privilege—of having served for years on our Council, shares our love for the Royal Zoological Society of Ireland. Just as the fond mother is pleased and gratified when her pet child is noticed, so, your Excellency, we, the Council, are pleased and gratified by your presence here to-day, and we thank you heartily for it.

"The Council assemble in these beautiful Gardens every Saturday morning, year in and year out. The breakfast party which precedes the business of the meeting is a well-known institution. But the public do not perhaps so fully understand that the breakfast is a fortifying appetiser, prior to serious business which has to be most carefully performed.

"The Council have to conduct the innumerable affairs of the Gardens. Questions of finance and administration have to be dealt with. The buying and selling of animals is often a critical and difficult business. Everyone knows it is a troublesome matter to buy a horse; it can therefore be imagined that the purchase of a live crocodile or a ferocious hyena is not devoid of anxiety! When the official business has been completed the Council makes a careful inspection of the Gardens, with the assistance of Mr. Hunt, the superintendent. They consider whether the lion cubs are old enough to be sold, and how the rats can best be excluded from the aviary. They order a new pole for the bear pit, or a new tub for the elephant. They hold serious consultations about the health of a zebra bull, or the suitable diet for a delicate leopard. They are anxious about the expense of hay, or the adequacy of the supply of superannuated cab horse. They have to witness Supple's latest development in the education of the chimpanzee. They have to think whether, after all, it might not be wiser to make a new den for the wolves than to repair the old one. They have to decide whether they can afford a pair—indeed, I should say two new pairs—of boots for the donkey which has to pull the lawn mowing-machines; and they entreat the Treasurer to spare fifteen shillings for the monkey which the poor old organ-grinder, with tears in his eyes, has brought in the hope of selling. Such is the business of a Council meeting.

"I suppose it generally happens that in a Society of this kind there is one dominant and masterful spirit who is the mainspring of the whole organisation. For some twenty-seven

years this position was filled—and filled most admirably—by our old friend the late deeply regretted Rev. Dr. Haughton. For that long period, first as Secretary and then as President, he was the life and soul of the Society. No doubt he was throughout assisted by a succession of zealous and capable colleagues who also loved this place. On this memorable occasion I cannot forbear from mentioning the names of a few of those who have co-operated with Haughton through these years, and who, like him, are no longer with us. I think first of that old and most valued friend of the Society, Maxwell Hutton, and to his name I must also be permitted to add that of Valentine Ball. Maxwell Hutton and Valentine Ball, in their respective capacities as Treasurer and Secretary, rendered inestimable service to the great work inspired by Haughton, and in both cases their love of the Gardens was inherited from fathers who had in their time also served as Treasurer and Secretary. Nor can I omit to mention some other losses still more recent. Your predecessor, sir, in the presidential chair was Dr. Gordon; truer friend this Society never had. Dr. William Carte, who has so recently passed away, was one of the oldest members of our Council. I need only now recall how forty-three years ago Dr. Carte presented us with a splendid pair of Bactrian camels which he brought back from the Crimea, where he had served with so much distinction. One more name must be mentioned. It is the latest loss to our Council, and the loss has been a great one. Long shall we deplore that most lovable of men, Dr. Nedley, whose delightful company for many years so largely added to the charm of our Saturday meetings.

"Our special object this afternoon is to inaugurate this new and commodious building—this Haughton House—which has been erected to the memory of the most remarkable man who has ever been associated with these Gardens. Those who have been long acquainted with the affairs of the Society will need no indication of what Haughton's work has been. But on this historic occasion let me point out some of the leading results of that work.

"I may commence with one of the earliest as well as one of the most difficult problems in connection with the Gardens which he ever succeeded in solving. This was not, as you might perhaps suppose, cutting the claw off a tiger*; it was something much more difficult. He obtained no less than £4,000 from the Chancellor of the Exchequer for the benefit of these Gardens! That took place thirty years ago, in the great days of Sir Henry Cole. I do not think we ever appre-

* See page 294, *post*.

ciated until quite lately the skill and resource which Dr. Haughton displayed in this transaction. Some of us recently tried to repeat the process. We endeavoured to obtain some further help from the present Chancellor of the Exchequer. I cannot trust myself to speak on the subject; it is too painful. Suffice it now to say that, if our failure was ignominious, it serves at least to enhance the glory of Haughton, who succeeded!

"That goodly sum of money which the State so kindly gave us thirty years ago sufficed, with careful management, for what I may describe as the re-endowment of our Gardens. Thus was our institution started upon the career of prosperity with which the present generation of animal lovers is familiar.

"The old aquarium—the first establishment of the kind, let it be recorded, attempted anywhere—was cleared away, and the beautiful new aquarium rose in another part of the Gardens. The shabby old monkey-house—there are others here beside myself who remember it—was replaced by the present commodious structure, which has proved so great a success that even the delicate chimpanzee finds the climate of the Phœnix Park hardly less delightful than that of the forests of tropical Africa. The lions almost fancied that they had been restored to the freedom of their native wilds in Mashonaland, when they were transferred from the narrow dens in which they had been previously cooped up, into the spacious apartments of the present carnivore-house.

"Looking from the balcony of this Haughton House we see a pleasing prospect around. On all sides we meet evidence of the labours of Dr. Haughton. Let me take a conspicuous instance. See that beautiful sheet of water opposite to us. We generally call it a pond, but we cannot call it less than a lake upon so august an occasion as the present. The Royal Zoological Society owes that lake to the energy of Dr. Haughton. I do not, of course, mean to say that Dr. Haughton made the lake; what he did was to obtain its inclusion within our boundaries.

"In my young days, while this side of the lake belonged, as at present, to the Gardens, the other side was part of the open park. The lake was, in fact, the boundary between the Gardens and the Park. It was a natural boundary, and in some respects an efficient fence. But, as we found out to our cost, the lake was not an efficient fence in all respects. It had some disadvantages. Let me mention one or two.

"I remember the day when the gardener came to the Council with bitter complaints about certain ravages which were made in his flower-beds. His seedlings were trampled upon, his carnations were devoured. Some unknown nocturnal marauders

were the cause of the mischief. The Superintendent, who resided in the Gardens, had also a report to make. He declared that on the night when these atrocities were perpetrated, hideous yells and roars from the hyenas and the lions kept him and his family from sleep. A watch was then kept, and the mysterious trespassers were discovered.

"Who would have suspected that those innocent deer in the Park were the culprits? It might have been thought that the vast pastures of the Park would have sufficed for them. The Fifteen Acres, however, they did not consider enough. It is ever the same old story—they must have this little Naboth's vineyard also. The stags used to swim across the lake at night to feast on the carnations. They came close to the lion house, close to the dens of the hyenas. The savour of game so succulent, so near, yet so unattainable, used to set the hyenas and lions frantic with excitement. A fence round the other side of the lake became necessary for the carnations, and necessary for the nerves of the lions.

"In early days, when one side of the lake was accessible from the Park, the scene when the lake was frozen was truly remarkable. Dublin poured forth its thousands. The lake was covered with sliders and skaters. But even if the lake were an admirable fence when it is water, it is certainly no fence at all when that water becomes ice. The people walked on to the ice from the Park, and they walked off the ice into the Zoological Gardens. Never in the whole history of the Society had there been such a marvellous number of visitors to the Gardens! The houses were thronged. The monkeys got more nuts than was good for them. The bear in the pit got so many buns that he thought the millennium had arrived. This wonderful development of the taste for zoology among the masses of Dublin was intensely gratifying!

"There was, however, one person in the Society who failed to wax enthusiastic over this remarkable zeal for scientific knowledge. That one person was the Treasurer. Under ordinary circumstances the Treasurer requires that each visitor to the Gardens shall enter through a turnstile, depositing as he does so a coin which suitably expresses his gratitude for the intellectual benefits he is about to receive. But when the lake was frozen the turnstile somehow ceased to revolve. It really became superfluous. The route into the Gardens *viâ* the lake was much simpler than the route *viâ* the turnstile. The coins, of course, could no longer be exacted.

"The Treasurer expostulated, and threatened resignation. He pointed out to the Secretary that, though the Gardens had been crammed for a week, there was not a penny in the till.

"A fence round the lake thus became indispensable, and

Dr. Haughton braced his energies to the problem, and the permission to put up the fence was at last gained by his determined perseverance.

"You will, however, please observe that permission to put up a fence is not exactly the same thing as the fence itself. The fence would have to be paid for by the Society. I must tell you how Dr. Haughton managed to pay that bill.

"Just opposite the carnivore-house, where, in fact, the open-air aviary now stands, there once lived—no, I do not mean lived, but there once reposed—a magnificent skeleton of the *Plesiosaurus Cramptoni*. The history of the Society's connection with this unique and tremendous fossil is somewhat remarkable. In the very early days, about the middle of the century, a prominent figure on the Council was Sir Philip Crampton, the eminent Dublin surgeon. On one occasion a grateful patient presented to Sir Philip a gigantic fossil reptile which had just been exhumed at Whitby. It was like an overgrown crocodile with a neck as long as that of a giraffe. This mighty sea monster was a new discovery of the greatest scientific interest. The finder took the opportunity of associating a becoming compliment with his gift. He named this splendid inhabitant of ancient ocean after the Dublin surgeon. He called it '*Plesiosaurus Cramptoni*.'

"As this animal was about twenty feet long, Lady Crampton considered that it would hardly be a becoming decoration for her drawing-room in Merrion Square. Accordingly Sir Philip presented it to the Zoological Society, of which he was then President. There for a quarter of a century this vast fossil monster remained. Some people thought that a great fossil was rather incongruous in a collection of wild animals. It was, however, a great attraction to visitors. Dr. Haughton used further to add that to the living animals in the collection these gruesome bones of the *Plesiosaurus* provided an edifying lesson on the shortness of life and the mutability of all terrestrial affairs.

"But you will not find the *Plesiosaurus* here now! Just as the owner of a great ducal house has occasionally been compelled, owing to pecuniary embarrassments, to part reluctantly with a renowned old master, so had the Royal Zoological Society reluctantly to part with its unrivalled *Plesiosaurus* to pay for the railings round the lake. For this remarkable financial expedient we were again indebted to the fertile brain of Dr. Haughton. At the usual meeting one Saturday morning, we happened to be in low water—in lower water even than usual—for the heavy bill for the fence had only just come in. Dr. Haughton was never seen to greater advantage than he was on these Saturday mornings. But this morning he excelled himself. He entered the room in the highest spirits

and announced the glad news that 'something had turned up.' He had found a purchaser for the *Plesiosaurus Cramptoni*. He had persuaded the Science and Art Department to buy this unequalled reptile at a handsome price for the National Museum. Depression vanished from the breakfast-table; the bank was mollified—for a time. Carking care had been dispelled; the *Plesiosaurus Cramptoni* had not lived in vain!

"From this incident your Excellency may infer that the eternal lack of pence which vexes public men has not been unknown even to former treasurers of this Society. Haughton's splendid enterprises could not be carried through without money, and the provision of this money was often a very difficult matter. I can assure you that problems connected with our financial relations have often given much heart-searchings to the Council. But I hasten to add that these are all matters of the past—the very remote past. We have only to look around at the prosperous condition of these grounds, and our well-filled cages, and the affluent state of the Society in general, to see how admirably the enterprise of Haughton prospered, and how greatly all naturalists are indebted to his courage.

"I have alluded to those deer which so greatly adorn this stately park which surrounds your Excellency's residence. This leads me to observe that Dr. Haughton had long been desirous of building a suitable house in the Zoological Gardens in which to display specimens of the many different varieties of the deer tribe. He felt a special interest in these animals. As a geologist—as an Irish geologist—he loved to tell of the mighty Irish elk, of that magnificent stag, which in prehistoric times abounded in this country. Great Britain did not seem to suit the constitution of this animal. It was in our beautiful Isle of the West, and over the mountains that confront the melancholy ocean, that this colossal deer loved to roam. Dr. Haughton delighted to point out the formidable antlers of the Irish elk in our National Museum. He used to explain why he, as an Irishman, was proud to look upon this ancient monarch of the deer tribe. 'How frequently,' he would say, 'my ancestors must have hunted this noble animal! How frequently this noble animal must have hunted my ancestors!'

"The mighty stag has been extinct—extinct from time immemorial. But in this country to which it so specially belonged, and in these Gardens where we still strive to maintain its degenerate kith and kin, the President and Council of the Royal Zoological Society, acting under the inspiration of Haughton, resolved to rear a monument to its memory. This monument was to take the form of a building which should offer a home to such relatives of the *Megaceros Hibernicus* as still survived, either in the Old World or in

the New. Such was the project. It was a project worthy of the best traditions of our Society.

"The site was forthwith chosen, the plans were prepared. Everything was ready except one trifle. The Treasurer once again made that tiresome remark of which we were all so weary —that there was no money! Here again the acumen of Dr. Haughton, by the discovery of an available asset, rendered much service to the cause of zoological science.

"It happened that there had been an institution in Dublin which bore the name of the Natural History Society. This Society was held in deserved honour, for it had done useful work in its time. It had stimulated the study of zoology and botany at a time when such stimulus was much needed. We who had to conduct the Zoological Gardens had often gazed with astonishment on the Natural History Society. Our astonishment arose from the fact that the Natural History Society had not only studied animals, but had saved money! It had accumulated capital, and had actually three hundred pounds snugly invested in Consols! This was prosperity indeed! But somehow the Society declined. It declined until it became extinct—as extinct as the great Irish elk itself. The Society vanished, but the Consols remained.

"The three hundred pounds seemed likely to become derelict. The Commissioners for the reduction of the National Debt had their eye upon it. But Dr. Haughton determined that they should not have it. He succeeded in persuading the courts that the Royal Zoological Society was obviously the legitimate heir to the Natural History Society. He promised that the sum should be expended upon a particular and patriotic undertaking with which the name of the Natural History Society should for ever be associated. The result was that the three hundred pounds was placed at our disposal.

"Having thus obtained three hundred pounds for the purpose of building the Memorial Stag House, obviously the next step was to enter into a contract for building the house at a cost of about nine hundred. But, of course, the house had to be built. Built it certainly was, and we pulled through somehow. If I remember rightly, we happened to have a long and severe winter at the time, and we were able to replenish our coffers by the receipts for the privilege of skating on our pond.

"Thus the stag house, in memory of the great Irish elk, often called the 'Herbivore House,' came to be added to the Gardens. The next question was how to stock it with animals. This also Dr. Haughton managed. He obtained animals on loan, animals by deposit, animals by gift, and when all the other methods failed, he obtained animals even by purchase!

"Everyone knew Dr. Haughton as an eminent man of science, as a resolute man of action, and as a brilliant humorist. Those who knew him well were aware that there was a sentimental side to his nature. An institution like ours has a pathetic—a deeply pathetic—side to all who are lovers of natural history. The pathos of the Zoological Gardens appealed powerfully to Dr. Haughton. Let me illustrate what I mean. At the upper end of our Gardens is a tall building which has now been assigned to the elephant. That building was erected when I was a child; it was erected for the giraffe which was presented to us by the Royal Zoological Society of London. But there is no giraffe there now! I greatly doubt if that building will ever be tenanted by a giraffe again. Close by was a noble circle of elm trees, which now includes the llama paddock; but that paddock is quite a recent erection. This enclosure used to be the home of that majestic animal the great North American bison. Many of us remember the bisons, a few of us remember the giraffe. But both their places are now vacant; bisons as well as giraffes are in these Gardens no longer.

"History tells us, your Excellency, of the thousands of wild animals which Titus collected for the games to celebrate the inauguration of the awful Colosseum. How easy it must have been for the predecessors of Dr. Haughton to keep a zoological gardens two thousand years ago! The earth seems to have swarmed with wild beasts then. How else could the Romans have brought together for a single triumph in the amphitheatre giraffes and zebras, ostriches and wild boars, lions and tigers, bears and hyenas, elephants, rhinoceros and hippopotamus in numbers so prodigious that, though the figures have been set down by Gibbon himself, I have not the courage to mention them. I do not want to tantalise our most excellent and energetic Secretary, Dr. Cunningham. Vast indeed was the population of the earth in wild beasts two thousand years ago. Let us see how stands that population now.

"It is certain that if a Titus had to open a Colosseum in these modern days he could no longer collect the five thousand wild animals whose slaughter historians declare was required to make a Roman holiday. Notwithstanding that we have discovered a new world, notwithstanding that the oceans are traversed in all directions by our ships, notwithstanding that steamers ever increasing in number and power throng every port on earth, notwithstanding that innumerable new countries are opened up to modern commerce, that products ransacked from every clime are being poured in here for our benefit with ever-increasing volume, there is, nevertheless, one description of import which is not increasing. Nay, rather, it is sadly

declining—alas! it seems as if we shall soon have to say it is approaching evanescence. Titus could bring thousands of wild animals to Rome, and yet we cannot get them in hundreds—hardly even in tens. In many cases we have to be content with units, and some splendid animals, alas! are no longer to be obtained at all. The larger wild animals of this globe are rapidly approaching extermination. Everyone knows this in a general way, but to us who have been acquainted with the wild beast market for forty years, the facts are brought home with terrible significance. The thought is inexpressibly sad to all true lovers of Nature. There lies the pathos of a zoological garden. Here we are permitted to cherish the few survivors of these expiring races. In these Gardens around us at this moment the closing scenes of the great drama of animal life on our earth are being played out.

"That forsaken bison park is but a symbol—a sad symbol—of a tremendous fact in the history of life on this globe. The loss is inevitable; it is certainly irreparable—just think how irreparable. Were the National Gallery and its priceless contents to be given to the flames, the world would weep for its masterpieces, but the first great shock over, mankind might draw some consolation from the fact that in the course of centuries or thousands of years there might—nay, there would—arise another Raphael, another Rubens, another Turner; but when the last graceful giraffe has been ruthlessly shot down, when the last springbok and the last zebra shall have gone the way of so many other lovely forms, there is no hope whatever of restoration. Our earth must remain to all eternity poorer—infinitely poorer—in objects of the most exquisite beauty and interest. Yes, to the lover of Nature, to the lover of the beautiful, to the Rev. Dr. Haughton there is pathos in a zoological garden!

"But I am warned that I must qualify what I have said. I note a reproving glance from the eye of our present most excellent Treasurer, Mr. Hogg. He apparently thinks I am entering upon dangerous ground. He is evidently afraid that my words may have a repressive, an undesirable influence upon those who have entered the room with the excellent resolution of becoming life members of the Society. Let me at once remove such fears. Remarkable as is the decline in the number of wild animals that come to market, there is something more remarkable still, and that is the pluck and spirit which the Royal Zoological Society of Ireland has acquired from the influence of Dr. Haughton. The scarcer the wild animals become, the more firm is the Society's resolve that here we shall have them. Our cages were never so crammed with interesting creatures as they are at this moment, and I know it is the

determination of the Council that, so long as this earth contains even a single wild beast, they will strive their utmost that the home of that wild beast shall be in the Gardens of the Royal Zoological Society of Ireland.

"The extinction of many races of animals may go on, but camels and elephants, being more or less domesticated animals, we shall still have with us. So long as the lions and other animals in our collection continue to carry out the precept, 'increase and multiply' * we may hope to give abundant hospitality to the king of beasts, as well as to many of his poorer relatives. Monkeys and birds will, for an illimitable period, continue to make our Gardens attractive. Dispel your fears, Mr. Treasurer! These Gardens will give to generations yet unborn the same instruction and delight which we ourselves have been privileged to enjoy!

"The name of the present President of this Society is a guarantee to the world of the efficiency with which its affairs are conducted. Every member of our body felt a thrill of pride when Lord Roberts of Kandahar consented to become our President. The Society over which you, sir, preside with such dignity resolved to mark in the most signal manner their sense of the services of Dr. Haughton to these Zoological Gardens and to the cause of science. They determined to erect a memorial which should bear his name. As soon as the project was started, members of all creeds and parties hastened to put their names on the subscription list. The Society determined that that memorial should be erected in these Gardens which he loved so dearly. They determined that the purpose of the memorial should be one for which they knew that his sympathies would have been enlisted if he were still with us. He loved to come to the Gardens himself; he loved to see others come. Everything which could operate as an inducement to the residents in Dublin and to visitors to our city to pay a visit to these Gardens had his cordial encouragement. He consistently maintained that the main function of Zoological Gardens was a useful and a noble one. It was to afford in the first place to men of science an opportunity of studying the natural habits of wild animals. For this he incessantly laboured. He was ready to study every circumstance of those animals while they lived, and he was ready with his scalpel to dissect them when they died. Then, too, he felt as the Council have always felt, the inestimable im-

* The Dublin Zoo has always been famous as a breeding place for lions. In a circular letter which was issued by the Secretary in 1900 to draw attention to the need for a new lion house, the following statement was made:—During the *last fifty years over two hundred lion cubs have been born in the Gardens, and these have realised by their sale over £5,000,* which sum has been expended on the improvement of the grounds, and on the maintenance of the zoological collection.

portance of this collection as an educational institution. Every project in these Gardens was to be subordinated to the main fact that the cultivation of science and the advancement of education were its primary objects. Even when financial difficulties pressed most sorely, and when suggestions were made that the resources of the Garden might perhaps be increased by adding to its attractions something in the shape of performances, as is the custom in gardens elsewhere, 'Not while I am Secretary,' was the dignified answer of Haughton. 'If this Garden is to descend from its high position as a school of natural history, and as a school of comparative anatomy, then I will have nothing to say to it.' I need hardly add, your Excellency, that in this lofty spirit Dr. Haughton was always supported most cordially by the Council, and there is no more thorough upholder of the high aims of the Society than Professor Cunningham, our present Secretary, whom we all hold in such high esteem.

"I have only to say on behalf of the many subscribers to the Haughton memorial, that they rejoice to throw open this building to the citizens of Dublin. It is their belief that it will add greatly to the attractions of the Gardens. Around the building are grouped cages in which some of the smaller and more interesting creatures can be displayed to advantage. In this spacious apartment, it is hoped that for many a long year to come, rest and refreshment will be provided for visitors. Let it not be forgotten by any visitor to this House that amongst those who have loved this Garden, and given their best efforts most freely for its service, one name is henceforth to stand in unchallenged pre-eminence—it is the name of Samuel Haughton."

I have reproduced the address practically in the form in which it was delivered. To the manuscript copy which I found among his papers my father had appended the following passage, which he evidently considered was not suitable for the occasion:

"Almost every spot in the Gardens is in some way or other associated with Dr. Haughton in the memory of those who have been long familiar with our cages and their contents. For example, there used to be near the monkey-house a set of dog kennels, in which Haughton, always a lover of dogs as of other animals, conducted some memorable experiments. He at one time conceived the notion—apparently suggested by homœopathic principles—that it would improve the Irish sheepdog if he could blend with the pure-blooded animal some slight strain from the Australian dingo. The experiments were highly

successful. Some of the remarkable animals thus produced were sent to the South of Ireland. The results proved to be of the most interesting character. That these dogs had an intense affection for the sheep entrusted to their charge, was never for a moment in doubt. Indeed, their ardour was so forcibly manifested that it was generally believed in the country that the ferocious wolves of antiquity had suddenly been restored to the plains over which they had once roamed. The Society experienced no further demand for their improved type of sheep-dog!"

In the above address Sir Robert bore testimony to the admirable services which Dr. Haughton had rendered to the Zoological Gardens. It is manifest that his brilliant conversation did much to enhance the pleasure of those who attended the Saturday morning breakfasts. My father had noted down some recollections of the famous Doctor:

Various anecdotes concerning Dr. Haughton come into my mind. He was a man of great versatility. He was not only a Doctor of Laws and a Doctor of Divinity, but a Doctor of Medicine, too. As a medical man, however, his activities were not confined to ministering to his fellow-mortals. On one occasion when a tiger at the Zoo was indisposed Haughton volunteered to act as veterinary surgeon. The great beast—it was one of the largest in the Gardens—was suffering agony from an ingrowing claw. Dr. Haughton decided that the claw must be removed. He immediately set to work to devise a tackle by which the tiger could be kept quiet. Various keepers were summoned to hold ropes which by some means or other were attached to various parts of the tiger's anatomy. It was the duty of the head-keeper to draw the limb upon which the operation was to be performed, towards the door of the cage, at which Dr. Haughton, armed with a formidable pincers, stood in readiness. The door of the cage having been slightly raised, the pincers were applied, when the animal sprang at Haughton with a roar which could be heard all over the Gardens—if not the Phœnix Park. None of the keepers had ever heard a tiger roar in earnest before, and the result was they all fairly let go their hold of the rope and bolted from the building. Fortunately, the door of the cage fell down when the tiger sprang, and the man with the pincers came to no harm. Nor was he in any way daunted by the incident. Walking slowly to the end of the lion house, he summoned the frightened keepers.

Having enticed them into the building, he locked both doors, and said he would not open them until the operation was performed. A second attempt was successful; and Haughton averred that the tiger whose pain he had eased always knew and loved him thenceforward!

Dr. Haughton's ministrations to a sick lion were recorded in verse by my old friend and kinsman, His Honour Judge Sir Thomas Snagge. It was written in 1864:

"Elegy on the Death of the Lion in the Dublin Zoological Gardens"

(*Vide* Official Report of Superintendent, *Saunders' Newsletter*, February 18th, 1864)

I

"Alas! Another heavy blow
Has added to the weight of woe
Already pressing on the Zo-
-ological Society,
-ological Society.

II

'Tis only one short week ago
(A fever 'twas that laid him low)
Death took the Lion of the Zo-
-ological Society,
-ological Society.

III

The keeper found him very low,
And sent a messenger for Pro-
-fessor Haughton of the Zo-
-ological Society,
-ological Society.

IV

The Doctor came with Foot not slow;
He found his patient but so-so,
And told the Council of the Zo-
-ological Society,
-ological Society.

V

He wrote a grand prescription, though,
'*R. Kinahan's Spir: oz. duo*
Aquæ oz. sex. sumat leo.'—
S. H., Physician to the Zo-
-ological Society,
-ological Society.

VI

They tried to make him drink, but no
Tee-totaller was ever so
Staunch as the Lion of the Zo-
-ological Society,
-ological Society.

VII

In vain they sought to urge the no-
-ble beast. That ' tumbler ' was no ' go.'
He thought that whiskey-punch was ' low '
For him, the Lion of the Zo-
-ological Society,
-ological Society.

VIII

They watched his every dying throe;
They rubbed him down from top to toe.
So died the Lion of the Zo-
-ological Society,
-ological Society.

IX

Some said it was the frost and snow;
Others declared they didn't know;
But all agreed that, high or low,
Than this there ne'er was finer show—
This feast of reason and this flow
Of whiskey-punch so promptly pro-
-vided by order of the Zo-
-ological Society,
-ological Society."

Among the stories with which Dr. Haughton used to enliven the Saturday morning breakfasts, I now set down one which, told as it was in his inimitable style, afforded us no little entertainment. It appears that the Prince of Mantua and Montferrat * had kept up a custom which had been instituted by his ancestors many centuries ago of awarding gold medals to men of exceptional eminence in science, literature, or discovery.

It was even said that Christopher Columbus had been a recipient of this distinction; but I think we may brush aside

* For an account of this extraordinary man the reader is referred to an article entitled "A London Munchausen," by C. C. Osborne, in the *Cornhill Magazine* for September, 1912. His name and rank as officially registered were Charles de Bourbon d'Este Paleologues Gonzaga, Prince of Mantua and Montferrat. He died at the age of 54, on January 17th, 1894.

the statement that Julius Cæsar and Charlemagne and Copernicus had also been gold medallists! In pious fulfilment of this splendid tradition of his illustrious house, the Prince searched the world for persons of the eminence suitable to receive the award of his gold medal. In the course of his survey he at length reached Ireland, and finding that no son of Erin had hitherto been made a gold medallist, he determined that he would award the distinction to two great Irishmen of the period.

He consulted Trinity College and the Royal Irish Academy. The authorities of the former, with the complete approval of the University, selected Dr. Haughton. The Royal Irish Academy not unnaturally nominated its President for the time being. This was Sir Samuel Ferguson, one of the most distinguished literary men in Ireland. Sir Samuel became first known to wide fame as the author of "Father Tom and the Pope" (*Blackwood's Magazine*, May, 1831). Perhaps the poem by which he is most widely known is "The Forging of the Anchor." The work of his life largely lay in the direction of antiquarian investigation and the study of Irish literature. He had also been associated with Bishop Graves in his valuable investigation as to the origin of Ogham Stones.

It thus came about that the two Irish *savants* who were destined for the honour contemplated by the Prince of Mantua were the Rev. Samuel Haughton and Sir Samuel Ferguson.

In due time the medals arrived in Dublin by special messenger, and were afterwards solemnly awarded to the distinguished men destined to receive them. The spirit in which the medals were received by the two recipients deserves careful analysis. Sir S. Ferguson, notwithstanding that he had received the blue ribbon of recognition for his literary work by election to the presidency of the Academy, was modestly pleased. The award was doubly welcome, coming as it did not only from the home of learning, but from Italy, with which country one of his earliest literary achievements had been associated. He therefore received the medal with the keenest appreciation, and gladly accepted the congratulations of his many friends, the more intimate of whom were privileged to see the famous gold medal. But these were not the methods of Dr. Haughton! Usually when a man receives a gold medal he deposits the prized article in his safe or lodges

it in his bank. But I venture to say that the procedure adopted by Dr. Haughton was unparalleled in the history of similar awards. When the medal was placed in his hands he neither opened his safe nor did he go to his banker. He carried the gold medal off to the chemical laboratory, and there he tested its specific gravity, with a very disconcerting result. The gold was not gold at all!

At this stage he reported the circumstances to us at the Saturday breakfast. As friends both of Ferguson and Haughton, we all besought him not to undeceive his co-recipient. We all knew how delighted Ferguson had been, and how keen would be his mortification when he found that his new decoration was made of base metal.

Dr. Haughton was an eminently kind-hearted man. I remember on one occasion when a well-known Dublin citizen had been bitten by a monkey in the monkey-house, with which he was incautiously playing, Dr. Haughton drove out to the Gardens the day after to inquire for *the monkey!* So we had hopes that Ferguson would have been spared the disclosure of the laboratory. But we were unfortunately too late. Ferguson had already learned the specific gravity of the alleged gold medal, for Haughton said that, as his co-medallist was an old and valued friend of his, he could not allow him to be imposed upon; and so, actuated by the highest sense of moral duty, Haughton had disclosed the distressing facts. Ferguson accordingly wrote a letter to the Prince of Mantua to the effect that it was the good intention of the Prince which he so highly appreciated, and not the intrinsic value of the medal, and that he felt quite sure that His Highness intended to send a genuine gold medal, but that some of those who were employed to carry out his wishes had not faithfully discharged the duty entrusted to them, and that if His Highness could assure him that his intention was to give a genuine gold medal, he (Ferguson) would prize this medal just as much as if the laboratory test had been in all respects favourable. Whereas, if His Highness could not give this assurance, he would have to take the painful step of returning the medal. No reply was received, and Sir Samuel's medal was duly returned.

In his young days Dr. Haughton, in partnership with his intimate friend, the Rev. Joseph Galbraith, established a class to prepare young university men for entrance into the army

through Woolwich. The Woolwich class was very successful, and the heads of the University gave it every encouragement. Dr. Haughton was an excellent "grinder," or, to use the English equivalent of the word, "coach." He used in later years, especially at the Zoo breakfasts, to boast of the successes he achieved in the Woolwich classes; and he used to expound the principles on which successful coaching was based. In illustration of this he told us how, just after a list of Woolwich successes had been published, he met the Provost—I think it was Dr. MacDonnell—who congratulated him on having secured the first two places in the list for Dublin men. But the reverend professor disclaimed the praise of which the Provost was inclined to be so lavish. "No! No!" said he. "We deserve no credit for having passed the first two men. They were clever fellows. It was their own brains and industry that secured their success. Their teachers deserve none of the credit. But look, Mr. Provost, at the last two men on the list, and then you will understand what consummate grinding means! They were stupid fellows, who ought never to have got in; but Galbraith and I set ourselves the problem of 'loading up' those two men with information so adroitly chosen and so skilfully implanted as to bid defiance to the most astute of examiners. We have succeeded, as you see; and that, Mr. Provost, is what we mean by true 'grinding'! Any credit to which the grinders are entitled on this occasion is to be solely associated with the two last names on the list." In later years Dr. Haughton described the subsequent career of the four candidates. The two clever men who headed the list romped through the Academy into the Royal Engineers. The other two, after repeated attempts, were unsuccessful, and, to use Dr. Haughton's own expression, they swam round and round Woolwich like goldfish in a bowl. This simile was obviously suggested by the aquarium in the Zoological Gardens! At last, in despair, the Woolwich authorities wrote to Dr. Haughton to complain of the hopelessness of the situation, and to suggest that as it was he who ground them into Woolwich—a fact of which he made no secret whatever—he should come over and "grind" them out! It is hardly necessary to say that this solution was impossible. By strenuous exertion one of them was forced through the examinations and obtained his commission, while the other had to withdraw from the Academy.

According to Dr. Haughton he entered the profession which he himself so greatly adorned, and ultimately became a rural dean!

I have alluded in the last few words in the preceding anecdote to the fact that Dr. Haughton was a divine. I never had the good fortune to hear one of his pulpit deliverances. They were very infrequent. In the course of a famous sermon which he preached in the University Church at Cambridge he said, quoting a French writer, that the whole history of life on this earth might be summed up in the conjugation of two tenses of a certain verb—one in the active and one in the passive:

I eat, thou eatest, he eats.
We eat, you eat, they eat.

With the terrible converse of:

I am eaten, thou art eaten, he is eaten.
We are eaten, you are eaten, they are eaten.

This I have taken from the account printed in Cambridge of this remarkable discourse.

But perhaps the most characteristic of his pulpit utterances was a charity sermon which he preached in aid of Sir Patrick Dun's Hospital in Dublin. It is necessary to explain that the scientific world of Dublin was at that time arrayed in two hostile camps over a point of interest to geologists. The question was whether the stone found in the great quarry at Finglas, near Dublin, was or was not that particular limestone which is called Calp limestone. Some said it was; others said it was not. In this, as in any other geological question, Dr. Haughton, who was Professor of Geology in the University, naturally took a keen interest. When he stood up to preach the sermon he saw in the congregation the late Sir Richard Griffith, who is probably best known to the public by his survey of Ireland which led to "Griffith's Valuation." He was also a diligent geologist, and, as it happened, one of the leading protagonists in the Calp view of the Finglas quarries.

With a view to the offertory, Dr. Haughton proceeded, to use his own expression, "to throw a fly" over Sir R. Griffith. He introduced a little story. He described how a quarryman had recently been brought into the hospital, having sustained a terrible injury to his head by a fall to the floor of the quarry.

"What," said the preacher, "caused this fractured skull? It was, of course, his fall on the stone at the bottom. But what was the stone? Was it ordinary limestone? No, my friends, it was *Calp limestone!*" When the collection came to be examined, the sidesman noticed a phenomenon not at all usual in ordinary charity collections. This was a crisp five-pound note in the plate. The explanation of its presence was given to Dr. Haughton by a gentleman who was in the pew with Sir R. Griffith. It appears that Sir Richard, in the first instance, had provided himself with a coin of small denomination, but that when the geologist heard the preacher aver that the poor quarryman had been smashed up by *Calp* limestone he took out his pocket-book, and from this well-lined receptacle he extracted a "fiver," putting it into the plate with the explanatory remark to his friend, "That it was as gratifying as it was unusual to find scientific accuracy in the pulpit!"

* * * * *

The death of Dr. Haughton came as a severe blow. My father wrote to a friend on November 7th, 1897:

"Alas! poor Haughton! My thoughts have been much with him the past week. I do hope that someone will do him justice in an obituary. The notices I have seen in the papers appear to me wholly unworthy and inadequate. For there was a grand note about the man, independently of his genius, which was great, and his wit, by which he was best known. The real note of the man was *unselfishness*. He struggled hard for his ends, and his ends were always to promote some cause which was worthy, or which, at all events, he thought to be worthy, and he never did a selfish thing or had a selfish thought in all his endeavours. He had a touch of sentiment, too, and exquisite sympathy with suffering of every kind."

CHAPTER XIV

VISITS TO NORWAY

IN July, 1890, Sir Robert Ball visited Norway under the auspices of the Vesey Club, of Birmingham, of which he was then President. My mother and my eldest sister (now Mrs. Meakin) accompanied him on this occasion. The two Vice-Presidents of the club, Professor C. Lapworth, LL.D., F.R.S., F.G.S., and Sir Benjamin Stone, F.L.S., F.G.S., were also of the party. He often spoke of the pleasurable experiences of this expedition, which was rendered particularly attractive by the presence of Mr. Lapworth, whom he always regarded as a prince among geologists. The following letter from Mr. Lapworth (September 28th, 1901) gives some indication of the kind of discussion in which the geologist and the astronomer were wont to take part:

"I am now back from wandering over the land and among old friends, from Cape Wrath almost to Birmingham. Your letter has followed me faithfully here.

"The description of the conglomerates of Norway which you give in the proofs enclosed is quite correct. But what is new to me is the occurrence of such conglomerates in the Romsdal. I know them well in the Kongevold-Doorefield ground. They also occur in the Bergen Waston country and elsewhere. But the two main points dwelt upon in your proof, namely, their occurrence in the Romsdal and their employment as roofing slates in Vossevangen, are both novel to me. At all events, I do not recall these two things, and I thought that I had a very tough memory as regards rocks and their places.

"In the Romsdal region there are magnificent *augen gneisses* and the like, which have all the outward aspect of pressed conglomerates, but they are quite distinct from conglomerates as regards origin. The *conglomerates* are *sedimentary;* these *augen gneisses* are *igneous:* the former *superficial* stuff (sub-aerial) sent down into earth crust from above and squashed; the latter infra-crustal subterranean stuff risen up from below into the earth crust and *deformed* there. The lenticular form of the lenticles in both

is due to pressure and forced flowage; but the direction of metamorphism—in the one—is, so to speak, diametrically opposite to that in the other. The crushed conglomerates are blocks assorted by the mechanical action of water lying in a paste of similar material more mechanically disintegrated and worn by water action. All is deposited material. The lenticular forms are subsequent deformed shapes due to pressure. The *augen gneisses* on the other hand are due to subterranean struggles, when the consolidating or melting (or potentially melting) material is undergoing excessive strain—mighty pressure—and perhaps solid flowage. The 'eyes' are not pebbles (and are therefore not older, so to speak, than the rest of the rock). They are, it is true, of the same lenticular shape as the squashed pebbles—because the surfaces are the same under the same condition of depth and pressure, and probably could not be otherwise.

"But the conglomerates are formed of pebbles set in a paste of smaller pebbles down to microscopic or dust-like pebbles, and are relics of the stuff of which all the rock and rock paste is made up. The *augen* are usually the acidic segregation from the enveloping rich paste and derived at its expense.

"The two things are so similar that they are repeatedly mistaken for each other, and are sometimes impossible to distinguish. But they are *homomorphous* and not *homogenetic*.

"Please remember that I do not deny for one moment that crushed conglomerates and slate conglomerates may occur both in the Romsdal and the Vossevangen country. Indeed, they are exceedingly likely to occur on the Vossevangen ground. But I have no recollection of seeing any in Romsdal. They are abundant in other regions, however, and your description of them is perfectly correct. The Romsdal rock I remember were *augen gneisses* and the like, and it would never do to claim these as conglomerates, from which they must be most carefully kept separate.

"I may, of course, be wrong; but in these days of dynamic metamorphism there is need for extreme caution, and it is best to make no reference to these two localities but to speak in generalities alone.

"I have cut the unsafe bits out of the proof. The rest is all right.

"Very many thanks for all the good things you say anent the Monday trip. Your partnership with myself on the journey from Trondhjem to Odde gave me, as you know, the keenest pleasure at the time, and I look back to it as one of the most delightful times I had in my life."

In 1896 he paid another visit to Norway. It was known that in August of that year the sun would be totally eclipsed,

but the only place within comparatively easy reach of England at which the phenomenon could be observed, was in the north of Norway. An official party of observers, arranged by a joint committee of the Royal Society and of the Astronomical Society, sailed on the s.s. *Norse King* to observe this interesting event. My father, accompanied by his brother, now Sir Charles Ball, Bart., and other members of his family, including myself, gladly took the opportunity of seeing what he so often described on the public platform as a spectacle of surpassing beauty. So far as the main object of the expedition was concerned, it ended in failure, but the occasion was nevertheless full of interest to the Lowndean Professor, as will be gathered from his own account of it*:

"We sailed from Tilbury on the afternoon of July 25th on the *Norse King,* a steamer of 3,000 tons. The arrangements for the trip were made by Messrs. Gaze, and there were 164 passengers on board.

"Chief among the party were the President of the Royal Astronomical Society, Dr. A. A. Common, F.R.S., who was at the head of that branch of the Government Eclipse Expedition which established itself on the north side of the Varanger Fjord, and Professor J. N. Lockyer, F.R.S., on board H.M.S. *Volage,* with the other branch of the Government expedition, who had secured a station on the opposite side of the fjord.

"The staff under Dr. Common's command consisted of Major Macmahon, R.A., Mr. A. R. Hinks, Mr. W. H. Wesley, Mr. J. Jepson Atkinson, Mr. T. A. Common, Professor K. D. Naegamvala, and Miss Klumpke. Dr. Common also had the energetic aid of his skilful mechanical assistant, Mr. A. J. Wooldridge. Many volunteers among the passengers gladly rendered them occasional help.

"In addition to what may be described as the official branch of eclipse observers there was a large number of astronomers on the *Norse King,* among the party organised by Mr. E. W. Maunder, then President of the British Astronomical Association, and Dr. Downing, the superintendent of the *Nautical Almanack.* The energetic observers of this party brought with them over thirty instruments of different types, in the hope of effecting a solution of the various problems which a total

* This was published in the *Times,* August 19th, 1896, and is here reproduced by kind permission.

eclipse presents. Among the other astronomers on board may be mentioned Dr. Isaac Roberts, F.R.S., the distinguished photographer of celestial objects. Many ladies interested in science were also to be found in the party.

"Our passage across the North Sea was not accomplished without bodily discomfort for many passengers, including not a few of the astronomers. The welcome shelter of the fjords was, however, duly reached, and then the rest of the voyage to Vadsö was delightful. Outlying islands generally bounded channels of smooth water. Through these we glided under skilful pilotage, fully enjoying the magnificent scenery. With only brief delays, the ship moved rapidly northwards, and even when we had to traverse occasional intervals of open sea, we were fortunate enough to find gracious weather awaiting us.

"The voyage to the North Cape is so well known that there is little to be said on the matter. The gradual lengthening of the day and the gradual vanishing of the night is always an interesting experience. The changes in the character of the scenery as the Arctic Circle was reached and passed were specially noticed. Though the spectacle of mighty snowfields, of glaciers which creep down towards the sea-level, and of vast tracts of bare and barren rocks testified to the inhospitable latitudes we had reached, yet occasionally I was astonished to find scenes widely different from those which we usually associate with the Arctic regions. We anchored for some time at Harstad, in the Lofoden Islands. Ample provision of carioles being forthcoming, a party of about sixty enjoyed one of the loveliest possible drives. The road at first wound along the deeply indented coast, disclosing magnificent views at every turn, and after a journey of about seven miles we reached the valley which contained the Lapp settlement, a visit to which was the ostensible object of the expedition. I am afraid that the Lapp settlement would have been found disappointing if any of us had come there with the expectation of being able to study primitive man under distinctly aboriginal conditions. Within a small enclosure, for admission to which a smart gate-money was exacted, were a couple of tents and a dozen Lapp men, women, and children. These people were dressed in their best, and were doing a brisk business in vending preposterous knives with reindeer antlers for handles, and many other objects of reputed Lapp manufacture. Their words of English and

their shrewd dealings made it impossible to regard them as specimens of unsophisticated man, even though a number of reindeer, looking shy and uncomfortable, were huddled together in one corner to produce some resemblance of reality. A Lapp baby sleeping comfortably in its mummy-like wrapping and an old man crouching in a tent seemed the most genuine specimens of humanity in the show.

"But whatever we may have thought of the value of the Lapp settlement from an anthropological point of view, we were enchanted by the extraordinary beauty of the valley where the encampment lay. On all sides verdure and luxuriant vegetation were the predominant features. It suggested rather the richest parts of Kerry or Devonshire than regions within the Arctic Circle.

"It was midnight on Sunday, August 2nd, when we anchored at Vadsö, in north-eastern Norway, at the latitude of 70°. Though we had actually passed by a day or two the possible time for seeing the midnight sun, yet night, in our ordinary sense of the word, had no existence, and all were on deck to obtain a survey of the place where we were to dwell for a week, and whence the great event was to be observed. The little town was prettily situated on the north side of the Varanger Fjord. There are no mountains in the neighbourhood, but the land slopes gently to the north, behind the town, to an altitude of a few hundred feet. In front of Vadsö is an island, and the sound between it and the mainland forms a harbour with ample accommodation for the Russian ships of small tonnage which frequent it; the anchorage for large vessels lies to the west of the island.

"The screw of the *Norse King* had scarcely ceased to revolve before some enterprising members of the party, midnight though it was, hailed a boat, landed on the island, and forthwith selected a capital site on the south side, overlooking the fjord, where ample room could be found for the thirty different observing stations belonging to various members of the British Astronomical Association.

"On the following morning, Monday, August 3rd, I accompanied Dr. Common when making a call on Governor Prebenson, the important official whose rule extends over the whole of Finmarken. He received us on this, as on subsequent occasions, with the utmost kindness and hospitality. He

promised every assistance in his power, and gave Dr. Common the liberty to choose any site he pleased on the hill at the back of the town. Provided with this authority, we walked up the hill at the back of Vadsö for a couple of miles to visit the stations which had already been selected and occupied by Dr. Copeland, the Astronomer Royal of Scotland, and Dr. Hasselberg, the Swedish astronomer. Though the day was fine, the accounts which we received of the previous weather at Vadsö were far from encouraging, for the preceding days had been extremely wet.

"As the result of this survey Dr. Common decided to place the station of the Government eclipse party at a point about a mile from Vadsö. Its position adjoined a toboggan slide which is provided for the winter amusement of the young people of Vadsö. The next step was to land the instruments and to have them conveyed from the pier to the chosen station. The carts which the town possessed seemed to have been previously engaged by the contractor for the new Vadsö waterworks. However, much energy was shown by the Government party, and certain carts were somehow obtained, so that by the evening all the cases had been safely conveyed to the station on the hillside. The portable huts were soon erected, and all was in readiness for commencing the laborious task of preparing the observatory for its duties on the 9th.

"Then followed five days of tremendously hard work by Dr. Common and his zealous band of assistants in the erection and adjustment of his instruments. The equipment he employed on this occasion was of special interest, inasmuch as it was the first time on which a certain important type of apparatus had been arranged for eclipse observation. The light from the sun was to be received on a mirror called the cœlostat. This mirror rotates about an axis in its plane and parallel to the earth's axis. If the mirror be made to rotate by clockwork, so that its rate is exactly half the rate at which the earth rotates on its axis, the light from the sun would be always reflected in the same direction, notwithstanding the motion of the sun. Two splendid flat mirrors, each sixteen inches in diameter, fashioned by Dr. Common himself with rare skill, were employed for this purpose. The telescopes and other instruments with which the observations were to be made, were mounted upon solid supports, heavily weighted with great

stones, in the collection and disposal of which Dr. Common obtained much assistance from the capable bluejackets who had been kindly placed at his disposal by Commodore Atkinson, R.N., in charge of the Training Squadron. Dr. Common himself, assisted by his son, Mr. Hinks and Mr. Wooldridge, proposed to photograph the corona and its spectrum. Miss Klumpke, belonging to his party, was charged with the time observations, while I had erected within Dr. Common's enclosure a small equatorial with which to make eye observations of a total eclipse, a phenomenon which, like most members of the party, I had never before had the opportunity of witnessing.

"During the days of our sojourn at Vadsö I visited the other stations, where preparations for the great event were in progress. The largest apparatus was that of Dr. Copeland, who had directed a forty-foot tube to that point of the sky where the eclipsed sun was to be. At the upper end of the tube was a six-inch object glass, and it was designed to take photographs of the corona on plates eighteen inches square.

"I was glad to accept an invitation to lunch from Captain King Hall, R.N., commanding H.M.S. *Volage,* of the Training Squadron. His ship was anchored at Brashaven, or Brassund, a beautiful spot on the opposite side of the Varanger Fjord, about fifteen miles south from Vadsö. The position was chosen so as to afford Sir Norman Lockyer a convenient base for his operations. After lunch we went in the ship's launch to an island a mile and a half distant, which had been chosen as the site of the observing station. We found everything there in readiness for the eclipse, and the professor was kind enough to rehearse in our presence the admirable drill which he had prepared for his staff. The sight was indeed a remarkable one. On this little island, in a romantic situation of wildness and grandeur, he had made elaborate arrangements for the orderly observation of the eclipse. Assisted primarily by his son and by Mr. Fowler, he seemed to have practically at his disposal the entire ship's company of the *Volage.* Much enthusiasm for the work animated the officers and crew alike, and a staff of seventy persons, the captain himself included, had been chosen, who were regularly organised to take their parts in observing the various phenomena. The work was divided into sixteen or seventeen different departments, each under the charge of a responsible

officer. The drill was designed so as to utilise to the utmost the limited period of 106 seconds during which the phase of totality lasted. Mr. Fowler had charge of the prismatic camera, with which notable results had been achieved in the eclipse of 1893. In this instrument a large prism is placed in front of the object glass. Each of the lines in the spectrum of the chromosphere produces a ringed image of the sun, and these rings are sufficiently clear to be separately distinguished. The drill in the use of this instrument was so complete that when Mr. Fowler had one attendant to hand him the plates and another to receive them, a bluejacket at the upper end to give the exposure, and a midshipman to act as time-keeper, it was possible for him to make no fewer than fifty exposures during the interval of totality. One of these occupied thirty seconds, another twenty, and another twelve, and the remainder were snapshots, as the whole had to be concluded within 106 seconds. The station of Captain King Hall was at one of the occulting discs. This was a dark circular piece of wood at the top of a high pole, so placed that it just cut off the more brilliant part of the corona. The observer, after totality had begun, was to be led blindfold to a chair, and then, the bandage being removed, he, with his eyes in the most sensitive state, was to draw the outlying branches of the corona.

"Another department organised by the energetic professor was constituted of a corps of draughtsmen. He selected the suitable men by a previous test of a very appropriate nature. The ship's company were brought in batches of twenty at a time into a darkened room, and were there asked to sketch a picture of the corona, which was presented on a screen by a lantern, the time allowed for the drawing being 106 seconds. In this way a band of about thirty had been obtained, each of whom had given satisfactory evidence of his capacity to make a faithful picture of what he might see during the brief interval of totality.

"A sad incident which occurred during our stay at Vadsö was deeply felt by many of the party on the *Norse King*. I allude to the death of Mr. Edward Howard, midshipman on H.M.S. *Active*, who was killed by a fall from the mast. His funeral in that remote region was attended by many of the passengers on the *Norse King*, including myself. The ceremony was an affecting one. Some kindly hands had strewn

the route from the pier to the little cemetery with heather. Many who were quite strangers to him were nevertheless much touched by the impressive scene. They knew it was the funeral of a gallant young Englishman who had perished in the discharge of his duty. He was being laid to his rest in an Arctic grave, surrounded not only by his sorrowing comrades, but by many other sympathetic English men and women. The inhabitants of all classes of the little town, and many Lapps in their quaint costumes, were present in respectful silence and attention.

"As the great day approached, the harbour at Vadsö presented a very lively appearance. One vessel after another dropped her anchor. We had, in the first place, the three ships of the Training Squadron—H.M.S. *Active,* H.M.S. *Champion,* H.M.S. *Calypso;* the *Konge Harald* was there with passengers who had come specially for the eclipse; the *St. Rognald* was similarly freighted; and there was the yacht *Myra* with a distinguished party on board. Both Swedish and Norwegian men-of-war had been sent to the station, and there were several foreign tourist ships. There were the *Neptune* and the *Thor,* containing many sightseers, and another vessel which had just returned from a trip with a large party from a region hitherto regarded as inaccessible by tourists—the ice sheet in the latitude of 81° 35′. There were trading steamers, and there was a whaler, with its crow's nest and its swivel gun. When all these were added to the normal shipping of Vadsö Harbour, which consisted of small Russian vessels which had come with flour and wood to barter for dried cod, it will be admitted that the total eclipse was, so far as Vadsö is concerned, a social no less than an astronomical event. The weather during the week had not been such as to give us much encouragement. Some days had been fine, some had not, and I rather think the latter were in the majority. However, we hoped for the best, and after no little labour on the part of the astronomers all was made ready by Saturday evening. But I do not think there was much sleep for anyone that night, we were too full of expectation; and those who had any duties of observation to perform had to leave the ship at 2 A.M. so as to be at their posts well before the phenomena commenced at four.

"Our first glance as we came up was, of course, at the sky. The decks were still wet with the heavy rain which had fallen

during the night, and the clouds were still threatening. There were, however, some breaks which gave us hope. I went up through the town, and found all the inhabitants astir. A stream of them were wending their way up the road to the hill where the observatory was placed. Indeed, I think that almost all the adult population must have turned out for the purpose. This will seem somewhat less surprising if it be borne in mind that we were in a part of the world where the day and night are curiously mixed, and where, in fact, the seconds of the total eclipse expressed the duration of the only darkness which had been experienced during the summer. Among the spectators were many Lapps, whose extraordinary costumes claim attention the moment the stranger sets foot in Vadsö. This astronomically minded race stood in circles round each of the encampments, gazing with more curiosity, perhaps, on the strange people who had come so far to see so little, than on the sight in the heavens. They were, however, then, as on all other occasions, respectful and well-behaved, and needed but little of the surveillance of the bluejackets at the disposal of Dr. Common.

"The instruments were duly opened; for it was decided that no matter what happened the contemplated programme should be faithfully carried out. I was stationed at a small equatorial telescope of three-inch aperture. It was with some hope that we saw a partial clearance of the sky, and the sun peeped forth. But I failed to see the first encroachment of the moon on the sun's limb. A cloud prevented that, though almost immediately afterwards I could see the advance of the moon, and thus learn that the eclipse had actually commenced. For an hour we had one glimpse after another of the resistless march with which the dark moon entered straight on the brilliant disc. Beautiful, indeed, were the cusps of light as they grew steadily narrower. For a long time there was but little appreciable effect on the general illumination of the earth. It was not until about four-fifths of the sun's disc were obscured that I became conscious of the increasing gloom, and felt as if some tremendous thunderstorm were approaching. Gradually the interest and the excitement augmented as the solar crescent became narrower and narrower. It was still only to be seen occasionally, and even then only to be seen through clouds. At last the crescent had become perceptible as a thin line, and some hopes were

indulged that it would remain visible up to the supreme moment of totality. But alas! just as the crescent began to shorten and approach the vanishing point, the clouds through which my vision was straining closed in again. I found it impossible to distinguish this extinction of light from the extinction of totality itself, and thus I was led to believe that totality had been reached some seconds before the actual moment. Those who were not engaged as I was at the telescope had a more accurate method of determining its advent by the advance of the shadow. Miss Klumpke was, however, so fortunate as to be able to note the exact moment through her telescope, and this is, at least, one valuable observation which is doubly acceptable amid the almost universal failure.

"Of the phenomena characteristic of a total eclipse—namely, the corona and the prominences—not a trace was to be seen. Not until after the precious 106 seconds had long expired was the sun again seen as a crescent on the other side. The plates were duly exposed, no doubt, but as the sun itself was not able to pierce the canopy, it could not be expected that its faintly luminous appendages could send a single ray to a plate. It has thus to be admitted that the object with which the elaborate instruments were transported with so much trouble to Vadsö has been entirely defeated.

"I recall the observation made by Dr. Common when he found that his labour had been in vain. When all hope of seeing the corona was over he said: 'Now I shall smoke a pipe!'

"But there are certain phenomena of a total eclipse which do not depend on the corona and the prominences, and these are in themselves so interesting and so striking that I feel heartily glad that I went to witness so sublime an event. I know that many others who were with us share the same opinion. The approach of the shadow is a spectacle of unparalleled magnificence, and from our situation at Vadsö many of the party were most favourably placed for its observation. The eclipse took place when the sun was east and the shadow advanced from the west. To reach us it had to travel within sight of the observers at Vadsö, for many miles over a mountainous district, and then for many miles down the fjord.

"Mr. Crommelin succeeded in finding the commencement of totality by the approach of the mighty shadow as a dark curtain

drawn over the sky, while the end of totality was sufficiently manifest by the sudden lighting up which so many observers in this as in other eclipses noted. The duration of totality appears to agree with the time predicted, but the beginning and ending appear to have been about three seconds before the tabular time. This will not be considered a great difference when it is remembered that it only corresponds to a departure of the moon centre from the tabulated place by an amount which is less than a ten-thousandth part of the moon's apparent diameter.

"Mr. Wesley and Mr. Green both testify to the artistic beauty of the phenomena of totality; they were struck by the indigo-purple colour of the clouds and the amber yellow light between, while at the horizon, tints resembling those of the setting sun were extremely beautiful.

"It must be confessed that the results of scientific interest are very meagre, but to many of us the occasion has been one of much interest and profit in indirect ways. There has been great opportunity for the interchange of ideas, and those in charge of elaborate instruments have been most kind in permitting others to learn their use. The attempt made to observe the eclipse has been a gallant one, and if so much well-meant effort has not borne all the fruit that we might have wished, it has, at all events, tended to show that astronomy was never before cultivated with the same vigour that it is at present. Shall I add, in conclusion, that the morning after the eclipse was one of cloudless beauty?"

* * * * *

During the outward voyage my father gave a course of lectures in the saloon. He dealt with the scientific aspects of the phenomenon which the party were about to witness, and he took the opportunity to explain why Vadsö had been chosen as a point for observation:

"Why did we not stay in London?" he asked. "Because the sun will not have risen at the critical time. Even at Bodö the sun will be too low. Speaking quite roughly, we may say that at any time the black shadow of the moon on the earth covers a patch about as large as Yorkshire. Though Yorkshire is a very large county, it is still only a very small part of England, and as our American friends sometimes remind us, England itself is only an inconsiderable patch of Europe, and

Europe itself is only a very small fraction of the whole area of the earth. The consequence of this is that at any moment there is only a very limited area of the earth from which it would be possible to see a total eclipse.

"The moon is moving very quickly, and consequently this shadow does not remain in one place, but it hurries along with considerable velocity. In fact, how quickly it actually moves can easily be realised by looking at a globe. *Here* is the point out in the North Sea where the shadow of our satellite first commences to run its brief earthly course. Taking its birth in those stormy waters which were kind enough to abate something—though not everything—of their habitual fury during the time of our recent voyage, the shadow entered Norway at Bodö, which you will remember we passed on the way up. Then, moving at a speed far swifter than that with which any cannon-shot was ever fired, it has crossed those deep fjords, wide icefields, and solemn mountain ranges which lie between the Varanger Fjord and the west coast. Then, hurrying along again eastward across the sea, the shadow crosses Novaya Zemlya, where, let us hope, that our friend Sir George Baden-Powell, with Mr. Stone, Dr. Gill, Miss Clarke and other astronomers will be successful in having effected a landing and given the shadow its due reception. Again crossing those wintry Arctic waters, the line enters bleak Siberia, and the shadow commences a mighty Asiatic journey of some thousands of miles. Doubtless it will surprise many a nomad tribe to find the sun disappearing for a while. You all remember the magnificent incident of this kind in 'King Solomon's Mines,' a description which makes every astronomer's mouth water, for on that remarkable occasion the eclipse was prolonged for a couple of hours, while we, alas! at Vadsö will think ourselves lucky to get one minute and forty-six seconds—or, rather, to give you the accuracy which is expected in such a scientific matter, we have exactly one minute forty-sixty seconds and four-tenths of a second. A friend of mine declined to come on this expedition. He objected to take his amusement in so highly concentrated a form! Even the odd .4 of a second would not tempt him! But to resume. The shadow in its progress hurries down across these frozen regions to Japan, and there we are assured that it will receive a very cordial welcome from the Astronomer Royal, Captain Hills, and Professor Turner. They will observe it from the island inhabited by the hairy Ainos. Let us hope that they have escaped all danger. The place they proposed to visit is rather desolate and uncivilised, and the main street at Vadsö is a Piccadilly compared to it; nor are the people yet in a condition to take advantage of the scientific opportunity afforded them. It has, indeed, been not obscurely hinted that they run some

little risk from the cannibalistic propensities of the Ainos, whose appetite for knowledge is such that they will, I understand, eagerly devour all sources of information! From there the shadow renews its ocean voyage. Hurrying along with a speed which carries it a third of the way round the earth in about three hours, it now crosses the broad Pacific. Doubtless it will lie over many a lovely coral island, probably be gazed at in astonishment by the mariners whom it may chance to encounter in those lonely waters, and then, thousands of miles from land, away in the direction of the Sandwich Islands, the moon's shadow will take leave of our globe."

In his third lecture, delivered on the ship a few days before the critical moment, he said:

"Even if the fates are unpropitious, I shall regard this expedition as a rare and interesting experience. We have seen those beautiful fjords. We have learnt to know and love one another. We have demonstrated to those who live in these regions that we are not a mere nation of shopkeepers! Nor have we failed to profit by our first experience of the Arctic regions. Some of us had conjured up a vision of polar bears warming their paws at the Aurora Borealis! But what have we found? Tall hats, pneumatic tyres, mowing machines, steam merry-go-rounds, barbed wire fencing, and the Salvation Army! * At Vadsö we have found many kind and generous hearts. We have been entertained by the Governor of Finmarken and his charming wife. It was a try back to the hospitality of the old Norse kings."

Certain incidents varied the monotony of the voyage home. At Tromsö the vessel ran aground. It was commonly reported that the engineer had gone full speed astern when he should have gone ahead. Whatever the reason, the s.s. *Norse King* ran backwards on to a muddy shore when it was nearly high water. The tide being on the ebb, there was nothing for it but to wait patiently until the returning waters should lift her from her perilous position. I say "perilous" as the idea that we were in danger got abroad amongst some of the passengers. One gentleman who had brought a collapsible boat with him as part of his luggage was over the side and into his frail boat in less than no time!

It had been arranged to give a smoking concert in the saloon that evening. There was some talk of postponing the

* All these tokens of an advanced civilisation were found within the Arctic regions.

festivity, but as the captain assured every one there was no danger it was decided to go on. Sir Robert was in the chair at the concert. Having reassured the assembled company by a message from the captain as to the safety of the ship, he said that he only desired to make one alteration in the programme. He would venture to suggest that the gentleman who had promised to sing "Rocked in the Cradle of the Deep" should give them a song more appropriate to the occasion, such as "My Lodging is on the Cold Ground." The laughter with which this suggestion was received clearly showed that the passengers were no longer in a very grave state of apprehension.

On the return journey my father narrowly missed seeing Nansen, for the *Fram,* on its way back from the North, arrived at Hammerfest three days after the *Norse King* had started homeward from that port. In later years, when he was chaffed about lecturing on an eclipse of the sun which he had never seen, he would reply: "It is no worse than Nansen lecturing on the North Pole, to which he has never been!"

When the vessel was about half-way down the coast a cablegram was received to say that the English visitors at a certain hotel would be glad to welcome the members of the Eclipse Expedition to a fancy dress ball! We thought at the time that a fancy dress entertainment was rather a tall order in the wilds of Norway, but rather than disappoint their hospitable countrymen the passengers determined to do what they could. Eventually two boatfuls of passengers whose attire was fanciful in the extreme, were sent ashore to attend the ball. One man was dressed as a Laplander; another, wholly disregarding the summer heat, was clothed from head to foot in a polar bear skin which he had purchased at Hammerfest. My father accompanied the party in his ordinary attire. Everyone was curious to see whether our ideas of fancy dress would tally with those of the English visitors ashore. What was our horror to find that no single one of the ladies and gentlemen assembled to greet us wore anything which could by any stretch of the imagination be described as fanciful. The look upon their faces is more easily imagined than described! They had come dressed in their best to welcome a party of savants; they encountered instead a number of people who looked like patients newly escaped from a lunatic asylum, who had ransacked the glass cases of an ethnological museum for articles of attire! Nevertheless,

the passengers "took the floor" for some time, and made as merry as possible under the circumstances. But it soon became apparent that, instead of being entertained, the dancers were themselves the entertainers! The windows of the ballroom (which was on the ground floor) gradually filled with the round faces of scores of Norwegian peasants, who were doubtless much impressed by seeing the kind of clothing which is worn by scientific English men and women; while as a climax, in the midst of the dance, Sir Robert was called upon for a speech! The cause of the mistake did not transpire until afterwards. It appeared that an error had been made in the cablegram. The words "fancy dress" in the message should have been "full dress"!

CHAPTER XV

VISITS TO CANADA AND THE UNITED STATES

SIR ROBERT BALL paid several visits to the New World. In 1884 he attended a meeting of the British Association at Montreal, after which he took an extended tour through the United States, delivering many lectures.

Amongst his fellow-passengers on board the s.s. *Oregon* (Dominion Line) were Mr. Williamson, S.F.T.C.D., F.R.S., Mr. H. Barton, Professor T. R. Jones, F.R.S., Professor Kirkland, the Rev. H. Swanzy, and Dr. Anthony Traill, afterwards Provost of T.C.D.

He kept a diary during this expedition, but it is for the most part a record of places seen and of distinguished people whom he met. There are, however, a few extracts which appear to be of general interest. The late Dr. Traill took a prominent part in the various recreations which were organised to amuse the passengers on the outward voyage:

"*August 18th,* 1884.—In the afternoon Traill started a game of hop-scotch, which seemed very successful. T. was himself so victorious that he has been acknowledged the champion hop-scotch player of the Atlantic Ocean."

My father was much impressed by the sight of the Atlantic in a storm:

"*Wednesday, August 20th.*—To-day a wish has been gratified. I have seen the wild Atlantic in a storm. I don't suppose the captain would have called it a storm, and the second officer told me that if they never had anything worse than this, then Atlantic troubles would be very small. But to one who had never seen anything but the Channel it was undoubtedly a majestic sight. The wind yesterday was from the north-west, and most bitterly cold. To-day it had gone round to the south-west. I went on deck in the morning, and found the sea tremendously high. Torrents of rain were pouring. After breakfast the gale had increased so much that one could not

cross the deck without holding on to the ropes which were stretched across the ship for that purpose. After breakfast a few of the more venturesome thought they would go to the stern and have a sight of the Atlantic billows. We crawled hand over hand along the ropes until at length we reached the stern, where the deck-house afforded some shelter. Here we could see the glory of Nature. Every moment the sea was close at our feet, then we were lifted aloft till the sea was fully thirty feet beneath us. The screw, being half out of the water, began to buzz round. Sometimes a mighty wave would come along, and it would seem impossible for the ship to escape a deluge, but she would rise so beautifully that a heavy shower of spray was all the damage done. The track left by the screw was exquisite, the bubbles of air which were carried down in its revolution giving to the sea patches of an exquisite turquoise, while sometimes, through the top of a wave, a lovely emerald was seen. The aspect of the sea often reminded one of views in miniature of mountain scenery. The waves would look like the mountains, with a long, irregular valley between. Sometimes I was struck by the appearance of a great basin hollowed out in the ocean, and by the stupendous massiveness of the seas. There was, as usual, the greatest difficulty in estimating the height of the billows. My estimate was an interval of about twenty feet from crest to hollow, but more experienced travellers said that ten feet would be nearer the mark. One or two more venturesome of the ladies came to the stern, among them a young lady who had many admirers on board. She was conducted to and from the stern by various swains, and if to brave the perils of the journey it was necessary to hold her hand very tightly, why, it did no harm to anybody! Of course, this storm led to much more sickness on board, but I am glad to say I have never felt a qualm, so I suppose I am now a seasoned vessel."

"*Thursday, August 21st.*—I was interrupted just now by the intelligence that an iceberg was to be seen. I went up on deck, and saw a truly glorious sight. There, on the starboard bow, about five miles away, were the lovely pyramids of dazzling white! We estimated the height at 200 feet, but it was very difficult to make any very accurate investigation. Indeed, we could not be sure as to whether the iceberg was above the horizon or not. The horizon line seemed to cross

the iceberg in front, at least the best glasses would show no wash on the sides. I was surprised to see the berg so brilliantly white. Others we saw looked quite black. It seemed to depend upon the way the sunlight fell. Altogether we saw about half a dozen great bergs; none were less than about four or five miles distant. There were small but brilliant pieces of ice floating past the ship. Some of the great icebergs showed the most beautiful Alpine scenery, and Traill was longing to be landed on one with a rope and ice-axe. They gave an imposing idea of the depth of the ocean when we remembered that the mass is six or seven times as great below as it is above. I would have liked to lie to and go off and explore the berg in a boat. The captain does not love them at all, and he says that there will be but little rest or sleep for him now until we reach Quebec, still 800 miles away. A glance at the map shows how these noble bergs come down from the western shores of Greenland or the opposite side of Baffin's Bay or Davis's Strait. Their ever-varying shape is noteworthy as we change our relative position in regard to them. I never regretted more than to-day my want of artistic powers."

"*August 25th.*—The first impression I got when I walked on the shore was the fact that many of the weeds and grasses were the same as those we know at home. The whole flora seemed to have been characterised by imported weeds. There were, however, numbers of plants to show we were not in England. Thus there was abundance of chicory, a rather striking one being a deep yellow (*Solidago*, is it?), a large tuft of which I afterwards noticed gracefully placed in the bosom of a smart Canadian girl."

"*September 12th.*—I started this morning with Goodbody, Fitzgerald, and Admiral Ommaney for Niagara Falls. To our delight the weather seems inclined to cool. Our route was a pretty one along the Lehigh Valley to Buffalo, and thence at midnight to the Falls. We entered a bus, our luggage passed the Customs in a twinkling, and we crossed the suspension bridge. There the roar of the Falls became audible, and then we drove to the Prospect House Hotel. This is emphatically *the* place to put up at here. We are close to the Horseshoe Fall, and from the door there is a superb view. At night all we could see was the white mass of foam, and we of course heard the thunders. All night long

our beds vibrated with the quiver produced by the water—100,000,000 tons of which every hour drop over the precipice a height of 160 feet. We anticipate a treat for the next few days.

"*September 13th,* 1884.—The first day at Niagara is a glorious sensation, but I am not surprised at people being disappointed. One lady was disappointed. Someone said that she expected to see the Atlantic Ocean pouring down from the moon! But it is far the noblest spectacle that I have seen—in fact all other natural phenomena, such as the glaciers, or the great mountains, of Switzerland, seem to pale in comparison with this unique sight. After breakfast we started, and, turning our backs on the Falls, crossed the suspension bridge and proceeded to Goat Island. Goat Island is a place of exquisite interest. In itself it is a beautiful park where the primæval forest has only been altered by a clearing here and there, and the cutting of the larger trees. It has one small island in the American Fall, and it has three small islands in the rapids over the Horseshoe. The magnificence of the rapids between those islands fascinated me. They are bridged over, and consequently there are dozens of places where most ravishing views can be had."

"*September 14th.*—There are several things at Niagara which especially struck me. (1) The multitude of places at which the Falls and rapids can be approached. You can actually put your hands into the water at the brink of the American Falls at both sides, and the same is practically true of the Horseshoe. (2) The beauty of the islands and the vegetation. (3) The splendour of the lower rapids. (4) The extraordinary calmness beneath the great Fall. This was subsequently explained by the very simple fact that the rapid water burrows under the mass of still water. I believe a boat can go up quite close to the Falls. We dressed in oilskins, after having removed our ordinary attire, and went to the Cave of the Winds. The noise and majesty of the Fall are most imposing, and I could not resist a mighty shout at the glory of the scene, though if my shout had been ten times as loud, it would not have been audible to the rest of the party. The circular rainbows were superb."

"*September 15th.*—Goat Island is a unique spot on this planet. It is many acres in extent, and is covered with beautiful woods and an undergrowth of wild vines and Virginian

creepers. There is a charming island known as Luna, which divides off the American Fall. In fact Luna cuts off the part of the Fall under which we went to the Cave of the Winds. Then there are three little islands—lovely gems—known as the Three Sisters, set in the fearful rapids. These islands are bridged, so that it is possible to sit at the edge of the rapids in these lovely spots; and an awful sight the rapids are either at one's feet or stretching away for a mile across to the other side. The purity of the water is one great charm, and the great pièces of waste timber now and then heaped in piles are a feature. From Goat Island, too, the American side of the Horseshoe can be approached to where the Terrapin Tower once stood. The sheerness of the Fall is remarkable, but it is shallow at the edge. The depth increases towards the centre of the Fall."

His second visit to the United States was in September, 1887, when he sailed with his son Robert in the Cunard liner *Scythia* to Boston, where he gave a course of lectures at the Lowell Institute. During his stay he was the guest of Dr. B. E. Cotting, the Curator of the Lowell Institute, at his hospitable house in Roxbury. His host and his charming family, for whom my father always cherished the warmest sentiments, spared no pains to make his visit pleasant and to introduce him to customs particularly American and Bostonian. My brother recalls how the table was designed to display American dishes such as squash pie, green corn, Boston baked beans and brown bread, and Washington pie. When the Washington pie was set before him, Sir Robert delighted his kind friends by remarking: "Why, it's a jam sandwich!" Thereupon Dr. Cotting, who had a wonderful fund of anecdote, told of an English friend who commented on the pie with the remark: "Washington was a great man, but —— his pies!"

My father's next visit to the United States took place in 1901, when he went on a lecture tour under the personal guidance of Major Pond, who made all the necessary business arrangements. The Major having visited him at Cambridge, Sir Robert wrote to his son Robert S. Ball (July 15th, 1901):

"Major Pond's visit here was an interesting incident. He was accompanied by his wife and son, and the three are a remarkable trio. I should imagine the Major to be of great energy

and push in business matters on the large scale. We have no very definite plan mapped out yet. He has made a number of engagements for me, but he had not the particulars with him. His wife's sister, the head clerk in his office, attends to such details. He said, 'If there is any business to be got for you I'll get it.' It is his custom (to use his own expression) to 'sell' his lecturers out to Institutions for some nights, while he tries to make as many engagements as he can on his own responsibility, and pushes and advertises the thing to the utmost. I am not very sanguine about a large pecuniary result, but I feel I shall enjoy the trip, and if I can strike oil at the commencement we may do well. I rather thought the Major was a little surprised to find how well known I was over here in the lecturing line. From this, and a few other things, it is plain that such fame as I may have attained in Great Britain does not seem to have extended across the Atlantic. However, he is resolved to boom me as much as he can. He is to meet me on the arrival of the steamer with a bevy of interviewers and reporters, who will chronicle for the delight of the American public my precise appearance, the baldness of my head, the glassiness of my stare, and the interesting points connected with the voyage. Then I am to stay at his house as his guest.

"I have fixed up the seven lectures at Boston, and yesterday I received the welcome announcement that I am to be given the Honorary Degree of Doctor of Laws at the Yale University in October.

"I don't think it likely that I shall get across to San Francisco, but I shall certainly be at Chicago, and I believe I am already engaged to appear at St. Paul and St. Louis."

Sir Robert sailed for New York on the s.s. *Cymric* on October 18th, 1901. Before leaving home he had arranged to write a series of collective letters to the family. These, to the number of seven, were duly sent, the first bearing the date November 3rd, 1901, and the last January 9th, 1902:

"St. Botolph's Club,
"Boston, Mass.,
"*November 3rd*, 1901.

"My dear Family,

"I think we arranged that it would be convenient that I should write a collective letter. At all events, I take it for granted you will be interested to hear of my travels, even though I have not anything very remarkable to narrate. So here goes. On the voyage I was placed at the captain's table and I found myself very well situated. On my left were Captain Yonge, R.N., and his daughter. Their home is in Devonshire, and they were on

their way to New Zealand *viâ* San Francisco and Honolulu. I had many an hour's pleasant walk with this exceedingly nice man. On the other side was a man from Philadelphia. He belonged to a watch company there where they make 3,500 watches daily. He has given me a pressing invitation to see their place. I did not, however, see much of him during the voyage. Opposite me were an elderly man and his wife, who lived at Oxford. He is a barrister, who is a railway contractor for amusement, and has estates in Georgia which he was about to visit. He had a son at Trinity Hall. Directly he heard my name he said that he had travelled with Robert and played chess with him throughout the voyage, and Robert had made so good an impression that his father was at once welcomed as an old friend.

"In the course of the evening I asked a question which anyone but a donkey would have asked long before. I inquired, 'When does the ship arrive?' I was horrified to hear the reply: 'On Sunday, *if all goes well*.' Others said not till Monday, or even Tuesday. This gave me an awful turn, for I was engaged to give my first Lowell Lecture at Boston on Monday at 7.45, and Boston is over 200 miles from New York, for which we were bound. An alternative occurred to me. I thought of going ashore at Queenstown. I could wait there till the following day, and catch the mail steamer *Campania*, which would sail the next day, but would soon overtake us. Indeed I was only deterred from adopting this course by the fact that I might not be able to get a berth in the other ship, while it would have involved the sacrifice of my White Star ticket altogether. So I thought I would chance it, and trust to the luck which I have had in similar emergencies.

"The next day there was a violent gale in our very teeth which reduced our speed very much, so that when the *Campania*, which left Liverpool on Saturday, passed us at 6 o'clock on Tuesday morning, although we had had a full day's start, I abandoned all hope of my first lecture, and felt even the second very risky. I then put the subject out of my mind as far as possible, and sought to derive what enjoyment I could from the voyage, and found it to be a very pleasant one.

"Although we had a gale, and though we had persistent adverse winds the whole way, yet the ship was so vast that as a rule waves had no more effect on her than if she had been the Skellig Rock itself! At night sometimes I used to watch the top of the mast against the stars, and could see no motion in it. I don't say we did not get something of a tumble now and then. One evening we dined with the fiddles on the table, but the captain said it was the only occasion on which the fiddles were produced during the four months he had been in command of the ship. There were a few gaps at the table, no doubt; but

then there are some people who get sea-sick even when driving over a canal bridge.

"On the upper deck of the *Cymric* there is a magnificent promenade. Captain Yonge and I generally had this to ourselves. The rest of the party seemed to spend the day stretched out in those awful-looking inventions known as 'deck chairs.' These were ranged on one side under what I may sufficiently describe as a veranda, and they all reminded me of that hospital at Davos Platz, where you were all so jolly well sold about the tea you expected to get! Each afternoon when the rain stopped and when the wind would allow us to stand (which it often didn't) we had a grand walk. Occasionally the captain of the ship, Captain Thomson, would join us.

"One day he asked me whether I would like to accompany him in his morning tour of inspection. Of course I went. The steerage accommodation is excellent, and I wondered how often these people in their own homes get such a dinner as the soup, roast beef and plum pudding that I saw being prepared for them. Such excellent accommodation as they have! There was a fine day room filled with neat-looking girls and women at their work, and a corresponding smoking-room for the men. Each of the married couples have a nice room to themselves. The single men sleep in bunks, which are arranged on a lazy tongs principle similar to the affair in the boxes of soldiers that we used to play with. In the day all the bunks shut up close to the side of the ship, and there is a fine dining-room as a result.

"The usual concert was held on board for the Liverpool and New York sailors' charities. Over £7 was collected. I was put into the chair. I had actually established a musical reputation on board by leading the singing at the Sunday service! I heard later that there were two professionals on board, but that Sunday was rough, and even my singing was as good as theirs on that day. The concert performance was a very feeble one. No lady could be induced to appear. As they put down as Part II. 'Address by the Chairman,' I was compelled to make a few remarks. I displayed a marvellous knowledge of the Missions to Seamen. This they could not understand, until I explained how it was I knew so much about it.*

"The great majority of the passengers were Americans returning home, and as we approached New York they appeared to be consumed with anxiety as to the Custom House inspection, as they are liable to pay duty even on a pocket handkerchief purchased abroad. I had also some misgivings on the subject of my slides. Dr. Cunningham had had to pay £11 on his in the

* Lady Ball had for many years been treasurer of the Cambridge branch of the Mission.

shape of duty, so that from one cause or another I had good reason to wish myself well on shore. On the last day the ship made great tracks, and late on Sunday night I awoke to find the engines stopped. We had anchored at Staten Island, there to await the quarantine inspection at daybreak, and the visit of the Customs officials. By about 9.30 we were in New York Harbour —and at last we reached the dock. It now seemed certain that I should catch my 1 P.M. train for Boston. The ship came alongside, and there, on shore, was the great Major Pond. Then followed a long delay about the luggage. I was asked a good many questions about the slides. 'How long had I had them?' 'When would I take them out?' 'Were they my own?' 'Did I intend to sell them?' At last they passed them and I was free. Major Pond engaged a carriage. They now charge only two dollars for a drive from the quay; it used to be pounds! The interviewer, of course, at once appeared, and I gave my opinion on all things in the heavens on the spot. I was then furnished with the list of my engagements up to date. It was evident that I was to have a very lively time of it so far as the number of lectures and the distances to be travelled were concerned.

"I had lunch with the Major, after which one of his satellites called a carriage and drove me off to the New York Central Depot. Good heavens, what a city New York is! The skyscrapers of twenty-seven stories; the hotels which beat any pretence of Aladdin's palace that I ever saw at the pantomime; the magnificence of the shops and the palaces of the residents. The brilliance and brightness exceeded on that lovely day even Paris itself! It seemed to me to be a 'New World' indeed! My luggage having been checked, I was deposited in a Palace Car, which soon started on the five hours' run to Boston. There I duly arrived just one hour and forty minutes before the moment when the lecture was to commence. It was indeed a very tight fit, after a journey of 3,000 miles. But never mind, I was in time. But I had had such a time of it from 6 A.M. that I was not in the best form for the lecture. I cannot otherwise account for the fact that I heard several complaints that I did not speak loud enough! This was a novel charge! A room had been secured for me in a fine hotel, 'The Brunswick,' which is directly opposite the 'Tech.' I was shown into a room heated by pipes like a Turkish bath. It had a beautiful bathroom attached, and was perfect in every way as soon as I turned off the heat. But I must say I felt very low and homesick that night, and would have given anything to cut the whole concern and go *right* home (I am gradually picking up the language!).

"Yesterday (Saturday) Professor Simon Newcomb came here to dine, and I was glad to have the opportunity of a talk with him. The evening was free, so I went to the theatre to see

'Uncle Tom's Cabin.' The public mind is greatly exercised on the negro question at present. There is one man of colour, Mr. Booker Washington, who has founded a great industrial negro college. Of him all men speak well; but when President Roosevelt invited him to dinner, he was forthwith denounced on one hundred and fifty platforms. His name has been hissed at public meetings, as his action gave mortal offence to the South. A Southern girl is reported to have said, 'I do not mind kissing a nigger, but I will not sit at table with them!' Mr. Booker Washington himself chaffed them all in a speech. He said: 'You whites came over here where you were not wanted, and you intrusively forced yourselves upon the aboriginal inhabitants. Now we blacks have a much better claim. We all came by invitation—by a most pressing invitation which we could not decline, and our kind hosts even paid vast sums of money for bringing us over!'

"To-day I went out to 'Blue Hill,' and had a pleasant lunch there with Mr. and Mrs. Rotch. He is the meteorologist who founded the Blue Hill Observatory, of which I have often heard. It is the highest point on the coast and commands an immense view. But the chief interest centres in the kites. How I did wish I had R. there! Mr. Rotch has great kites which ascend to the height of three miles. The 'string' is piano wire, and there is a steam engine for hauling the kites down again! They are the curious box shape. Each kite costs £12, and carries a set of self-recording instruments, showing the temperature, pressure, and velocity of wind and the degrees of moisture. I greatly enjoyed all I saw. Mrs. Rotch told me that when crossing over in the steamer last August she happened to talk to a lady who said she was Mrs. Huddleston, of Sawston Hall, near Cambridge. And now I have brought my record to the evening of Sunday, November 3rd, when I am sitting in the club writing these lines. I will try to write another such letter next week giving a further account."

"NEW YORK,
"*Thursday, November 28th,* 1901.

"MY DEAR FAMILY,

"Some three weeks must have elapsed since I wrote my first and only collective letter,* and if I have not written again it is not, indeed, for want of something to tell you all, but because I have been on the run without any cessation ever since I came over! One afternoon about ten days ago at 3 P.M. it suddenly occurred to me that I had actually nothing to do until it was time for me to go to dress for a dinner party. This was a unique experience, and the afternoon was passed in writing a few necessary letters relating to my movements. Both letters and replies to invitations

* He had, however, written many letters to my mother.

have been shamefully neglected. The volume of work I have in hand will be understood when I say that this is the 29th day since I landed, and that I have already given twenty-four lectures. Nine of these were in Boston, which has been my headquarters up to the present, but now the Boston lectures are over, and I take my way to the South. My address will be as before, c.o. Major Pond, Everett House, New York.

"I will now give a general account of myself for the last three weeks. Let me commence on November 14th, which was largely devoted to matters connected with the 'Tech,' where Robert's memory is well preserved. Many people told me they were there with him as a fellow student. Professor Lanza, whom Robert will remember, asked me to lunch at his house, and there were eight or nine people there, including his sister, who says R. used to go and play chess with her. Lanza was not married in those days.

"After my lunch with Lanza I had a few visits to pay, and then went to dine with Professor Munro at the Technology Club. After that I gave an address to the members on 'The Ice Age.' All the leading people of the 'Tech.' were there, and the room was packed with present and former pupils. The thing went really very well indeed. But my night was not yet over; for after returning to the club I went to the station, and there entered a sleeper for New York. The Pullman sleepers give more room than those beds in which we came home from Switzerland. The long car is lined with them, in upper and lower berths, with heavy curtains in front.

"I woke in the morning to find myself in New York, and certainly each glimpse I have only makes the wonders of that city more impressive. A view from the harbour on a bright day can only be likened to some astonishing conception of Gustave Doré. It looks as if it were on a hill, but the city is on a dead flat, and the hill-like appearance is given by the twenty-seven-story buildings, which are at a little distance from the water. A church which used to be the highest spire in the United States has a most curious appearance among these monsters, which seem to start, as it were, from a level about the top of the church, while they have ever so many magnificent flats far away above the top of the spire. I stayed for the night in the Grand Union Hotel, close to the great New York Central Railway Station. If you could only see the waiting-room of white marble, which is as big as King's chapel! I was made free of the Century Club at New York, where I was caught by interviewers, who abound everywhere. There is a man here who has some little repute as an astronomer. He had some conversation with me, and Major Pond tells me that he got fifty pounds from his paper for what he sent them as the account of the interview! I need not say any-

thing about the lecture that night at a place called Morristown. However, I met some nice people there, and by one of them was taken over the New York Mutual Life Office. If anyone desires to know what American business enterprise means, I recommend him to go and see this building. It has only got eighteen stories no doubt, but the beauty of the offices would be rather surprising to anyone familiar with similar places in England. The president's rooms are decorated and furnished as rooms might be in Windsor Castle, for the president says he is accustomed to nice things in his own home, and he does not see why he should not have them in his office also. The business there transacted is on a scale one might expect. They tell me that two hundred and fifty applications for new policies are received daily, and they sometimes issue policies for a million dollars! In this place, as elsewhere, it seems to me that the Americans trust each other with greater freedom and confidence than we do.

"The next day I was due back in Boston, and I was to dine with Mr. Percival Lowell. There was a nice party at the house of his sister, Mrs. Roosevelt, sister-in-law of the President. At the party we had Professor Pickering, the great astronomer at Harvard College, Professor Reine, professor of mathematics, Professor Cross (whom we all remember at Zermatt), the President of the 'Tech.' and others whom I cannot recall, and a pleasant night it was. The claims of Boston are always being jeered at by other towns; for instance, a New York paper, in its items of intelligence, says: 'The sun is 95,000,000 miles from Boston,' and that a Boston man, after hearing *Macbeth*, said he didn't think there were five men in Boston who could have written Shakespeare! But these gibes have a foundation. There is certainly a most brilliant and cultured society of men and women in Boston. I was often astonished at the things they were familiar with, and they know more about England than do most Britishers. I had no lecture this night, which was fortunate, as I was quite hoarse with a cold.

"On Thursday, November 21st, I went down to Wellesley College. Professor and Mrs. Pickering came with me. Miss Whitney received us at the station with a carriage and drove us to Wellesley, another of those wonderful ladies' colleges. Of course we had to see the Observatory, a white marble building, and, of course, we had the usual mass of presentations. It seems as if I have done nothing since I came, except hold a sort of continual levée. There was no lecture, but I was suddenly called upon to explain to a crowd 'How I first came to work at the Theory of Screws.' Then back to Boston and to dinner at Mr. Lawrence Lowell's. This was given in my honour; in fact in this case, as in every other, I have had to choose the day myself. The last Boston function was the dinner given in my honour at

the Tavern Club. This is a club mainly of literary, scientific and artistic people, all of whom turned up. Many of them I already knew, Professor Morse, and the Lowells, and Professor Chandler, and Professor Farlowe (who was one of the guests at the Zoo breakfast in 1892); but many scores of new ones were presented. There was a great dinner, and then a speech from the president. G. L. Dickinson, Fellow of King's College, was there also, and Professor Armbruster. Both of these have been giving Lowell lectures. Thus in a great and festive gathering my visit to bright and beautiful Boston came to an end.

"Tuesday, November 26th, at 9 A.M., saw me off on my way to Concord, N.H. There I had two lectures, but my greatest achievement was to see Mrs. Eddy. I never before saw a really divine being. Her central hall is there, and the lady conductor who was with me said she drives out every afternoon in a carriage and pair with coachman and footman, and just as she said so the veritable carriage appeared. Inside was a venerable and dignified old lady over eighty. She has, I believe, millions of adherents all over the world, but I am afraid she has not a great deal of honour among most of her own townspeople."

"ON THE TRAIN NEAR LAKE ERIE,
"*December 11th*, 1901.

"MY DEAR FAMILY,

"I am still on the rush. The last two nights I have been travelling, and I travel again to-night. But the Pullman sleepers are very comfortable, so this is no hardship; and indeed it agrees with me, for, in good hour be it spoken, I have never felt better in my life. I shall take up my parable where I left off, at the Thanksgiving turkey at Major Pond's on November 28th.

"The guests were Sarah Grand, Max O'Rell, Miss Proctor, daughter of the astronomer, and Mrs. Seton Thompson, wife of the naturalist. He is all the rage over here just now. Mrs. Seton Thompson asked me afterwards 'If many Englishwomen smoked.' I was delighted to say that I had never seen any other British female perpetrate such an atrocity except the old newswoman in College Green, who had a cutty pipe! Max O'Rell was excellent company, and is a good-hearted, genial man. The feast, in accordance with the correct Thanksgiving Day tradition, was of a Gargantuan order. It takes the place of Christmas with us, for though December 25th is observed here, it is, I am told, rather as a day of gifts and Christmas trees, than as an orgy of solid feeding. (Parenthesis. The guard here calls out 'Ann Arbor.' I am sure this does not mean much to any one of my readers, but it was here that Dr. Brünnow worked in the Observatory before he came to Dunsink; here it was that he met

and married the daughter of the President of the University of Michigan.)

"After I had eaten my share of turkey and as much as I could of the two-pound slice of mince-pie, which custom imperatively demanded should be placed before each guest, I started with one of the lady guests and Mrs. Seton Thompson in a carriage and pair, provided by the Major, to take us back to New York. How many of you know that New York is on an island? To reach it from Jersey City we had to drive *vid* the ferry, a huge steamer which takes carriage and all on board.

"In the great station at Jersey City I repaired the ravages of the night's travel. I ascended a throne to allow an artist to 'shine' my boots. It is an elaborate function. Several different preparations are put on, and finally the edges of the sole are painted with varnish; cost, 5d. Then I submitted to the barber. This is an American luxury which I appreciate. It is also an elaborate and tedious function compared with the scraping and gashing in my own toilet room. I emerge like a new-born babe with the fragrance of Araby the blest! Then I get my breakfast. This, like everything else, is always ready in America, and then I start for Baltimore. At Baltimore, as at all other University towns, a truly royal welcome awaited me. Dr. Gilman (an old friend), who has just resigned the presidency of the Johns Hopkins University, was at the station to receive me. Then I was taken off to a luncheon where the chief notabilities were assembled. This began at three (I could not arrive earlier), and then we went to the President's to a reception, at which all the University were present. Then back to dinner at Dr. Gilman's (*en famille*).

"They knew Mr. Maxwell Hutton, having stayed at his house during the Tercentenary at Dublin. As soon as dinner was over I went to the University, where I was told everybody who was anybody at Baltimore had assembled, to hear me discourse on 'Time and Tide.' This was Saturday night, and the next day I had the offer of being a Presbyterian with Dr. Gilman, or an Episcopalian with Mrs. Gilman and her daughters. I chose the latter, resisting a strong inward temptation to be a stay-at-home atheist for the day, trying to cope with an appalling arrear of letters unanswered, even of invitations not replied to, and not even read. Everywhere I go I receive a bundle of letters and telegrams. After lunch I started for Washington. There I was received by Mr. Charles Bell, cousin of the renowned Graham Bell, his next-door neighbour and kinsman in another sense, for they married sisters. My host left Dublin in 1873, and is now head of a bank; indeed, he is the owner of it, and is greatly respected by everyone. He took me home to his beautiful house, wife, two pretty daughters and two boys. The day

being lovely they brought me out in a superb carriage for a drive. Washington is the stateliest of cities, the capital of capitals. It has spacious avenues and magnificent residences. I saw the modest White House with the flags showing that the President is at home. There are no sentries; everyone may go up to and into the White House without let or hindrance. The Capitol, so the House of Parliament is called, is the most impressive building I have ever seen. It is on an eminence, and the city radiates from it. Then we drove off to the country, and my host took me in to call at a beautiful house, the home of his mother-in-law. There I had another experience of the serious danger of expressing admiration for anything. The lady, Mrs. Hubbard, whom, of course, I had never seen or heard of before, happened to have lying on her table a beautiful book, just out, in two volumes, describing the Harriman expedition to the North Pole, or thereabouts. It is filled with photographs, and when I expressed my admiration of it, she at once said, '*It is yours.*' My remonstrances were futile. Her son-in-law was directed to take it to the carriage, which he did. Another instance took place yesterday. Mr. Warner, of the great firm who made the Yerkes telescope, showed me some beautiful binoculars that he is making which I admired. The result was the same; a beauty in a case (wholesale price £9) arrived last night. I expostulated, said I had only one eye, and was only accepting under false pretences. No use, home it goes! In future I intend to reserve my admiration for the Capitol at Washington; that will be safe. Two other smaller books and a fine portmanteau, or dress suit case, I have also acquired on the same terms. But this is a digression. I go back to Washington, where I had indeed a most cordial and distinguished reception. You will remember it was Sunday, so there being no lecture, there was first of all a small dinner party at Mr. Bell's, the two guests being my old friend Professor Newcomb, whom I was glad to see looking much better than when I met him at the Master of Sidney's in Cambridge, and also Mr. Graham Bell. It was a delightful party. In the evening it was followed by a reception, attended by all the scientific men of Washington and many other notable people. I was specially glad to see General Powell, a famous soldier of the war forty years ago, who has since distinguished himself by a voyage down the Canyon of Colorado. He is without a *right* arm, and his bosom friend is a general of the Southern army, erstwhile his redoubtable antagonist, who unfortunately lost his *left* arm, and it is interesting to note that those brave warriors of hostile armies are now on such terms that when one buys a pair of gloves he sends the odd glove on to the other! I cannot remember the tenth part or even the fifteenth part of the number of people to whom I have been presented. Everything develops into

a function. I thought I should have a few quiet hours on the following day, but how could I refuse Professor Newcomb when he offered to call for me in his 'buggy' at 10 A.M.? He duly appeared at the appointed hour, and we drove by a long route through the wonderful growing suburbs of Washington to the Observatory. We had much talk, for, as you all know, Newcomb is one of the greatest mathematicians in the world, and we had much to discuss. All the staff were in evidence at the Observatory, a beautiful new place recently erected by the nation. The nation can well afford it, for in this happy country they have £20,000,000 a year of revenue beyond their expenses, and this notwithstanding that they pay £30,000,000 a year of pensions arising out of the Civil War forty years ago! This is believed to be an awful abuse, but the nation seems content. One of the biggest piles of buildings in Washington is the Pension Office.

"Then Newcomb drove me to what is one of the wonders of the world, the Congressional Library. It is a marble palace of art. Each of the vast corridors appears to be made of a different kind of marble, and I have no vocabulary to describe the great hall. In a thousand years it may be the same wonder that the Doge's Palace is now. In my Philistine view it is infinitely more beautiful and splendid than all Venice put together! But the beauty is apt to make one forget that it is a *library*. All I can say is that no one in Great Britain has the faintest idea of what a library can be or ought to be, until he has paid a visit to Washington. The Map Room alone would be a vast library anywhere else. The books are delivered from the 'book stacks' to the readers by beautiful machinery on something of the principle of the machine for giving change in shops. Mr. Putnam, the head librarian, and a few of the more important people have a daily lunch party in a room at the top which is reached by an elevator. A superb view of the city and the incomparable Capitol is obtained from this room. I was the honoured guest. The day was nearly over by the time I left the Library, and when I was brought back to the house I found, as usual, that there had been numerous callers and invitations. There was barely time to dress for dinner and be off to the lecture. I was introduced by Professor Newcomb to a vast audience, and things went very well. That is a very fair sample of my day for the last six weeks.

"Tuesday, December 3rd, found me on the way to Richmond, the capital of Virginia, where I was booked for three lectures on three consecutive nights. They made me a member of the club, and the first man I spoke to was the son of Lieutenant Maury, who wrote 'The Physical Geography of the Sea,' the first book that interested me in natural science. Maury is a Virginian. The people in the club gave me that genial welcome which Southerners can give. And the ladies were not behind. A

deputation came to ask me to name an hour for a reception at the Women's Club, and it *was* a function! There were women from New Orleans, women from Georgia, women from South Carolina, and, the best and proudest of all, from Virginia. I found a dais erected in the club room, on which I was expected to stand and speak. I pointed out that I had come expecting the ladies to speak to me, and now it appeared that I had to speak to them! I do not remember what I said, but we seemed to get on all right. The lectures were given at Richmond College, and did well. The Governor of the State was there each night, and vast and enthusiastic audiences. When Kathleen reads this it will interest her to know that the success of the Spiral Nebula was tremendous. A man came up afterwards and said: 'Sir, I knew you as a man of science, but I never before knew you were so admirable an *artist*.' Those white threads, you see, escaped his attention.

"I was taken to the 'Constitutional Conference' to hear a debate on the election of judges. I would like to try and give you an imitation of one orator. What it was like, you may imagine from the sly remark made to me by the President, next to whom I had the honour of sitting: 'Some of them seem to think it is the thunder that kills and not the lightning!'

"The Court House in Richmond where the meetings were held is in a park abounding in fine grey squirrels. I bought a pocket full of pea-nuts, and the squirrels swarmed to me, taking them freely from my hands and even running up my legs. People are at last learning that more pleasure can be had from these wild creatures by making friends with them than by shooting them. Seton Thompson, who is here lecturing with the greatest success, is doing a very useful work in teaching this.

"To-night I give the thirty-fourth lecture. I got to this country six weeks ago yesterday, and I leave in the *Saxonia* on January 11th. The rush has at least had the effect of qualifying me to enjoy to the uttermost an afternoon like the present.

"My next letter must resume at Chicago."

"Cedar Falls, Iowa,
"*December 14th*, 1901.

"My dear Family,

"I write this in a very comfortable hotel at a table near a window, and outside the next window stands a thermometer which an hour ago showed

Twenty-two degrees below zero.

Now, 9.30 A.M. with a bright sun shining it is much milder, only 20° below zero. The night before last the temperature was 40°. In twenty-four hours it had fallen 50°. I am glad to have had the opportunity of seeing and feeling what such a condition is like.

"I knew it was getting cool yesterday, but on arrival here at five last evening I was certainly astonished to hear the temperature was 10° below zero. Further, I had the not very comforting assurance that the lecture was to be given two miles out of town, but that the hall could be reached by electric cars. The experience of the night was certainly a most unusual one, as I shall proceed to describe.

"I have been overwhelmed with attentions in other places, some of which I shall have to describe, but on this occasion, owing to the circumstances of the lecture (it being to the State Normal School), nobody seems to have thought it his business to look after me. The lanternist, however, who was professor of chemistry at the place where I had lectured the night before, most kindly came down to the station and met me in the dark, and showed me the way to Burr's Hotel, a very neat, clean and cheap place. The professor and I had our 'supper,' beefsteak, with brandy cherries, some mysterious but quite nice salad, hot wheat cakes and maple syrup, and coffee. Then I got myself ready and we started for the tramcar, which passed the corner. There was a biting wind, but it was only a few steps, and there was some attempt at heating the tram by electricity. When we reached the school there were two hundred yards or so to walk up the avenue. There was a terrible wind, and even two hundred yards in such a wind at a temperature of 15° is no joke, especially when I was not well prepared for it, though I had one comforter on. 'Take care of your ears,' shouted my guide, 'they may be frostbitten even in this bit.' For observe that owing to the rain twenty-four hours before, followed by this awful frost, the path was so slippery that I could only walk slowly. I huddled up my coat about my ears, and *twice* my hat blew off (of course I should have had a cap), but my kind guide recovered it each time. My ears were safe, but my hands, and especially the damaged little finger, were quite numbed by the time I reached the building. For once I could have found use for my buffalo coat. Even labourers in the streets often wear handsome fur overcoats. Once in, the warmth of the house was very acceptable. The lecture was the only depressing function I have had. I believe I was in good form, as good as ever. The audience was of young men and women who are being educated by the State as teachers, but from first to last I utterly failed to make them attend as audiences attend elsewhere. I did my level best, but it was flogging a dead horse all the time. Soon after I began, they looked about and yawned and whispered, and so it continued, except that none of them went to sleep. It seemed to me as if they were usually lectured to death, and made up their minds from the first that they would be awfully bored. The lanternist, who has had much experience, and who worked for me the night

before, told me he never saw such a set. I have had several lectures to school or college audiences before, but they were always most exhilarating and went splendidly. Then follows the strangest part. After the lecture is over I am usually crowded with kind hosts and offers of attention and people who come to tell me of this, that, and the other. On this occasion neither the president of the school nor one of its professors, teachers or students, not one human being came to speak to me, which, considering the night and the difficulties of getting back, was scarcely even human treatment. The only two individuals were the lanternist and the night watchman with a lantern, both of whom were as kind as possible. Then the problem was how to get home. The temperature was down another five degrees or so, and the trams only passed at very irregular intervals, and to wait down at the end of the avenue for the tram would, I believe, have finished me off in five minutes in that awful cold, though the wind had somewhat lessened; and I could not risk walking home on account of the danger of slipping. The lanternist had ordered the only vehicle in the place to come out at eleven and bring back his traps, and so I arranged to travel back with the cylinders and him. Not till eleven-thirty did he appear. I was beginning to make up my mind to sleep on the chairs in the lecture theatre, but at last an extraordinary conveyance, something like an old Dublin inside-car on four wheels, drove up to the door. I had got on my cap this time and tied the comforter over it and my ears, so I was all right with a pair of gloves on. After driving out of the way to another house, the man stopped and said we had better get out and go in here as there had to be a wait of a quarter of an hour, and we should be frozen in the car. We asked why, and the only explanation forthcoming was that he had promised to pack a box for a man and bring it to the station. We huddled into the hall of a small house, which was warm as all these houses are. At last the box appeared and we started again, the big gas cylinders rolling about in the vehicle with ominous bangs, and a torrent of 'pen-knives' pouring in at an open window in the front of the vehicle. We drove to the station where the gas and lantern were to be deposited, and then came the real trial of the evening, and the greatest trial of my life! The lanternist, ever kindness itself, insisted on sending me on to the hotel and walking back himself so as not to delay me while he was 'checking' (do you understand Americanese?) his traps. He stood out in the middle of the road and shouted out to the driver, at a temperature of fifteen degrees below zero, and without the slightest consideration for my feelings, the following awful words:

"'DRIVE THE OLD GENTLEMAN TO BURR'S!'

"Oliver Wendell Holmes says that the first time a man hears himself described as 'old' he receives a terrible shock, and this last blow was indeed crushing. The inexplicable part is that, notwithstanding the narrow escape of my ears in a blizzard, notwithstanding the atrocious stupidity of the students, and the fiendish cruelty of the professors, notwithstanding that in the valley of the Mississippi I for the first time heard myself publicly described as an old man, I arrived at the hotel in a shocking state of good humour, good spirits, and mental contentment, and presently, tucked in a cosy bed with the thermometer going to the dickens outside, I slept the sleep of the just!

"But I have got out of order. I was so full of my last night's experiences that I began with them, whereas I should have begun with Wednesday, December 11th, when I went to Chicago. I reached this wonderful place at 6.30 in the morning, where at Hyde Park Station I found Robert's friend, Mr. Horatio Wait, Master in Chancery, awaiting me with a carriage. He drove me to his house in the suburbs at a place where some sixty years ago the buffalo roamed and the Red Indians scalped each other, but now full of avenues having magnificent houses and spacious grounds round them, the effect of which is greatly enhanced by the absence of walls and railings. This is indeed noticeable everywhere. About noon we started off to the Quadrangle Club, where I was to be entertained by Professor James, and the Dean and the professors of the great University of Chicago, endowed with untold millions by Rockefeller. This was quite a function, and the names of the guests were announced in the papers beforehand. I sat on the right of the host, and next me was Professor Hall, my astronomical friend. There was also another Professor Hall, a professor of Latin, who knows many Cambridge people, and there was a professor of *sociology* and a professor of *neurology*, not to mention the more ordinary subjects. Of course, my health was proposed, and I had to respond, and then there was much general and pleasant chat. One professor told of some Englishman, who when a Chicagoan boasted that the visitor would be shown a city fifty years old with a million inhabitants, said he would much rather see a city a million years old with fifty inhabitants! At Chicago co-education flourishes. The number of girls in the University is increasing rapidly. They recently captured most of the prizes. 'Never mind,' cried an undergraduate, 'let the girls take the prizes, we'll take the girls, and so it will be all right.' After my evening lecture I went to the station and boarded the sleeper for the fourth consecutive night, refusing I know not how many invitations to dine and stay, and what not, and also an invitation to a lunch to be given by the 'Tech.' students now in Chicago in honour of Robert's father.

"After an excellent night's sleep I woke pretty early, and in the early light I had my first look at the Mississippi, and indeed it was not without some emotion that I saw the Father of Waters. I don't think that my first sight of the Nile (even if I ever get it) will fetch me so much as my early morning glimpse of this majestic stream of America. My destination was Davenport, a little town on the great river. It is resolved to grow into a mighty city. One of the first questions I was asked was: 'Had I ever heard of Davenport before?' Such an awful question. Of course I hadn't! I didn't even know then that Quaker Oats were made thereabouts (5,000 barrels *daily*). Even if I had known of this title to fame it would hardly have done to mention it, for my most kind host, a *lawyer*, has started in opposition 'Eureka Oats' with which he intends to whip the Quakers.

"He came to meet me. The top story of his house is a museum of archæology, chiefly Mexican and Indian prehistoric remains, and it contains other objects of interest. He and his wife made me so comfortable, and gave me what I specially wished and asked for, an absolutely quiet day. There were torrents of sleet and rain, so there was little inducement to go out. I spent half the day in reading Booker Washington's life, a most interesting book; 'Up from Slavery' is the title. Then we had the Unitarian minister to lunch, and a great discussion about 'University Extension,' which seems to flourish in this country. I was then glad to go back to the study and have a doze. At dinner there was a large party to meet me, and I was introduced to Mrs. Putnam, who, as she told me, was the only lady president of an academy in the world. And then the heinousness of my ignorance about Davenport stood confessed, for this ladies' academy has great collections, and publishes transactions which are exchanged with all the societies abroad, and this in the Wild and 'Woolly' West; for it will be remembered I had crossed the Mississippi. I have refused, had to refuse, many pleasant invitations, but the most heart-breaking refusal occurred here. In the Mississippi here is an 'island' of 1,000 acres, I believe. The greater part of this is literally in a primæval condition, for the whole island belongs to the Government and they use part of it for an arsenal. But on the rest a superb golf course has been laid out. Just imagine my feelings at having to say 'No!' to a proposal to play golf on an island still in a state of Nature and lying in the Mississippi!

"My lecture at Davenport had been organised by the Press Club. There was a splendid house, and after the lecture the inevitable 'reception' followed. The newspaper element is a strong one here in all the towns. Many of the journalists and editors begin by being compositors. I was presented generally to a room full of Democrats and Republicans, silver men

and hard money men, proprietors, editors, compositors, and for ought I know newsvendors as well.

"Bright people, most of them, full of talk and life, and all young. Everybody is young over here. Indeed, I sometimes pray, 'Give me back, give me back, the wild freshness of morning,' that I might begin again in this wonderful country. But probably our own is not too bad.

"I have been travelling all day in a temperature of 20° or less. Please observe that is 52° of frost as we count it. Even in the North-West that is considered cold, yet I think very likely there is more suffering from cold in England than here. Every railway carriage, every waiting-room is most comfortably warm. In the houses all the doors stand open, and the warmth is abundant and under control. Fires are rarely seen, and even when they are it is more for show, as the needful heat is supplied by the inevitable hot air from furnace or pipes.

"If, my dears, you value this scrawl at all, then you must thank the thermometer rather than your husband and father. The trains are late, and I am beguiling the hours by scribbling these words with the stump of a pencil about as long as my nail. The little wayside station is named Albert Lea, and it lies out in the middle of the prairie, or, rather, what was the prairie, but has now been broken up with innumerable homesteads, each with its comfortable farmhouse, each with its windmill for pumping water. For many hundreds of miles all round, this flat rich land extends, and I believe there is great prosperity among the farmers. This is the country which we used to see offered in blocks of one hundred acres to each settler who would come here. The land which used to be bought for a dollar an acre is now worth twenty or fifty times as much.

"I ought to say that the glorious sunshine has brightened up the whole day, and now that the wind has ceased the weather outside seems most agreeable, and except that the visible breath extends about six feet at each expiration, there is nothing obviously different from a very sharp and clear frosty day at home. Robert, however, cautioned me not to try long walks under these circumstances, and I am obeying him, though if it were not for the slipperiness a brisk walk this brilliant afternoon looks very tempting. Everyone here takes a profound interest in the thermometer. In the place where I am now it was 30° below zero last night. I am told this will not last longer than a few days. It was foretold. The weather prophets announced it twenty-four hours ere it came, so that all had their furnaces put into good order to fight the foe when it arrived. I am now (Saturday) on my way to Minneapolis, the great city where the flour of the world is made.

"A German here, who tells me he was a professor at Halle,

has just spoken to me to say how much he and others were interested in the lecture last night. I asked him what he thought of the audience generally, and he says the girls are for the most part farmers' daughters who come up to the Normal School to be trained as teachers, and that they know nothing whatever, and that they care about nothing except getting a certificate which will enable them to teach school and then catch a husband, so it was satisfactory to have this confirmation. The Christy Minstrels would have been more to their taste than 'Time and Tide.' Though I say it, the lecture in its present form is really a good one, as I have abundance of the best evidence, so it is satisfactory to learn from this man that my effort was not altogether thrown away. The dollars, however, were paid all right.

"I don't seem to be picking up many good American stories. The fact is, I see very little of their newspapers, and I cannot say I admire them. I believe I am honoured with occasional notice, but as I am generally away from the place I don't see them. I got a piece of good advice the other day. 'You need never mind,' said my friend, 'what you say to a newspaper reporter. He will put down whatever suits him, and in any case nobody will believe for a moment that you said what he represents you as saying, so it is clearly a waste of valuable truth for you to expend any of it on him.'

"My next letter will take up the parable from Minneapolis."

"THE WEST,
"MINNEAPOLIS, MINN.,
"*December 16th*, 1901.

"*En route Pennsylvania, Limited,*
Pullman Vestibuled Train.

"MY DEAR FAMILY,

"The temperature has gone up at a bound. From being between 20° and 30° below zero, it has gone up to zero to-day. This is regarded as warmth here; in fact, so much so that the town of Minneapolis has been excited to-day over a mad dog! We were hurriedly turned back from a street we were entering by the intelligence that a dog was running amok, and had bitten two men already. I did not see the dog, but one of my escort of two did. My anxieties during the day were not so much to keep out of the way of the dog as to keep myself right end up, for the walks, I need hardly say, are very slippery. I have become Americanised to the extent of a pair of 'rubbers,' and I shall put them on to-night as they are said to lessen the risk of a fall.

"When I was a boy attending Dr. Burke's school in North Great George's Street, Dublin, herds of wild buffalo used to resort to the Mississippi to drink. On the spot where those

buffalo quenched their thirst now stands this fine city of Minneapolis with 200,000 people! It is the twin of the city of St. Paul, on the other side of the river. There is great rivalry between these two cities. Indeed, it is stated that the use of the New Testament has been forbidden in the schools of Minneapolis because that city is not mentioned in Holy Writ, while St. Paul is! These great cities of the mighty North-West are mainly devoted to flour and timber. The timber industry ceases in the winter owing to the frost; so I went to see the former. I spent a couple of hours in the mightiest flour mill on earth, Pillsbury's, where the daily output is 12,000 barrels. We were received by an imposing 'guide' covered with medals like the Lion King at the circus. But a refined ear detected the brogue, the genus being Irish, the species Dublin, and the variety Kingstown. He and I discussed King O'Toole and Glendalough on the way up in the lift. The place is truly astounding. The flour goes through fourteen processes before 'Pillsbury's best' is reached.

"Nothing has amazed me more in this country than the Universities. Every State has its University, and the endowments flow in millions, while even in such a remote place as Minneapolis the students are counted in thousands. The valley of the Mississippi must in time become one of the greatest centres of population the world has ever known. The winter weather is delightful. All day there is a brilliant sun, and the air is so bright and invigorating that it stimulates work and exercise of every kind—of brain no less than of body. It is hard to believe that for the last week the temperature has hardly ever been so much as zero, 5° or 10° below zero in the mornings, and only a few degrees above at midday. Mind, I mean zero *Fahrenheit*, so that when I read in the paper that the temperature in London is 50°, that means it is 60° higher than it is generally in the mornings here. But no one seems to suffer from cold, though occasionally people are seen wearing *ear muffs*. If there is much wind your ears may become frozen before you know it. But you will know all about it in due time! Except for occasional slipperiness (I have been down twice already) the winter is truly glorious, and infinitely better than the summer. I do not wonder at the Americans' love of their magnificent country; 'God's own Country,' it is called, and each State is so proud. 'I am an Iowa girl,' says one, 'and I am proud of it,' and another dark-eyed beauty will say, 'And I am from Louisiana,' and looks even prouder still, and well indeed they may be.

"But to my narrative. I had now reached the furthest point of my travels. There is, alas! a sad want of proportion between the size of the United States and the length of human life. I should like, indeed, to have gone just another 1,800 miles to California. They tell me that in one night you pass from the

frost-bound country all around us here into a paradise of birds and flowers. But I had to face eastward; so after my lecture was over I went 'on board' the Pullman, and was soon asleep.

"In these frosts the trains have been greatly delayed. Even though the water may not actually freeze in the boiler, some of the outside pipes may go wrong, and, in any case, it is not easy to keep up the necessary temperature when the thermometer is about 60° below the average temperature of the year; whatever the reason, we are very late; but at last on Tuesday morning, December 17th, about 11 A.M., I looked out of the window and saw Geneva Lake, while bright and glorious in the lovely sunlight stood the Yerkes Observatory! *

"Professor Hale, the director, was waiting for me with a carriage and pair. After driving over what was probably in some sort a road, but which seemed to me like a mixture of open country and snow drifts, we reached his house. The site is indeed superb. It stands near a lake about as large as the greatest of the Killarney lakes. Around the shores of this lake are the palatial summer houses of Chicago millionaires. Mrs. Hale was away with her children in Chicago (I saw her afterwards), but a man and his wife, who also belong to the Observatory staff, keep house for Professor Hale.

"As soon as I had removed some of the stains of travel, we went to the Observatory. It is indeed a wonderful place. They can make anything there from an eye-piece to a ten thousand-dollar telescope. The mighty instrument, covered by a dome as big as the dome of St. Paul's (to be strictly accurate it is five feet less in diameter), is worked by electricity. The whole floor, which is seventy-five feet across, glides up and down to correspond with the telescope, so that there is no clambering up and down ladders.

"I received a warm greeting from my very valued friend Professor Barnard. There, too, I saw Professor Frost and others. Professor Hale seems to have the great gift of discerning likely and promising young men.

"The evening was fine. I had gone with such protection as I could get from a temperature of 42° of frost, as we should call it. It was one of Barnard's nights. He has three nights a week with the great telescope, the other nights being allotted to other observers. We found what looked like a moving cylinder of fur coats within the axis of which the great Barnard was to be found moving about, running as briskly up and down as if he were playing football. Indeed, he had need to be well clad,

* The Yerkes Observatory, which is the observatory of the University of Chicago, is situated at Williams Bay, on the shore of Lake Geneva, Wisconsin, about 100 miles from Chicago. It was richly endowed by the late Mr. Charles T Yerkes, the Chicago "street-car" magnate.

for that night he worked from five in the evening till six in the morning. The man who works the mechanical parts is called Sullivan, and it did not seem hard to guess where he must have come from! I spent a couple of hours there, and I saw some nebulæ, superb objects well calculated to show the unique power of this instrument. Once before I spent a night observing with the thermometer at zero. It was at Lord Rosse's, in the great frost of 1866. But I thought a couple of hours enough at present, and so I went back to Professor Hale's, where, as usual, I slept with little more than a sheet over me.

"The next day—last Wednesday it was, but it seems a month ago—I spent looking at photographs and many other objects at the Observatory. The new star has now developed into a nebula, and the portions of the nebula, which are flying off with the velocity of light, are actually shown in these photos. At present the matter is not understood; but I do not think I have ever heard of anything in astronomy which has astonished me so much. Here I may remark on Marconi's wonderful success in sending his messages across the Atlantic. From what he told me last June it did not in the least surprise me.

"Then dawned Thursday, the 19th, another lovely day. I think I ought to draw a veil over the proceedings of this day, or at least the first part of it, for I allowed the base animal and ferocious instincts of my nature to have full licence. It had been settled a week before that this forenoon was to be devoted to seeing the sights of Chicago, and my intellectual friends had proposed to take me to the Art Gallery, where some wonderful Russian pictures were exhibited. But I put my foot down. 'I will not,' I said, 'waste my precious time in Chicago in going to see pictures, Russian or otherwise.' Then they suggested a visit to the libraries. 'I am sick of libraries,' I said. Then they proposed to show me over the new buildings of the University. 'Bother the University,' was what I indicated in, I hope, more civil language. 'What, then, will you see?' said the intellectual circle around me. I said: 'I will look at nothing but

THE STOCKYARDS.'

If you could have seen the look of horror and disgust at this brutish announcement! One fine old gentleman, a Scotsman, Mr. Geddes, a grand old laird with an estate in Scotland and a great business in Chicago, shouted out: 'And I will take you there!' Thus it was all arranged; so at 10 A.M. on Thursday a carriage and pair drew up, and my good friend came out. 'Are you ready? Are you quite sure you will be able to stand it? Have you stout nerves?' were questions I readily answered in the affirmative, and so I started in much the same frame of expectation as an ancient Roman would set out for a pleasant

afternoon at the Colosseum. I think I must withhold details as to the establishment where 40,000 hogs and a corresponding number of cattle are daily slaughtered. If I went into particulars, some of my readers might not have at hand what I heard afterwards Mr. Geddes had brought, in case I needed it—a flask of whisky, but I insisted on seeing *every* detail and flinched not, nor did I blench, so as to call for the production of the whisky. I shall not forget the sights of that morning, and I will tell it all to any of you, my dears, who may desire further information.

"Having seen how the beef and bacon of the world are provided, I was next taken to the 'Board of Trade,' where on a great floor are three small 'pits.' In each of these pits an eager, noisy crowd was assembled. They seemed to act like maniacs. I stood at the brink of one pit which appeared to be the liveliest. In that the 'wheat' business is done. My friend Mr. Geddes said, 'Now look here'; he called out some words; instantly the crowd of eager faces turned towards him, in a moment the thing was done; he had sold 10,000 bushels of wheat. The *smallest* quantity ever sold there is 5,000 bushels, and millions are dealt in daily. The second of the pits is devoted to bacon. But do not think you can go there to buy a few rashers for your breakfast! By a nod or a wave of the fingers you sell or buy 5,000 barrels. You cannot do less, for that is the smallest unit. The third 'pit' was devoted to Indian corn. The din was deafening. It was as if the very life of each man depended on the transactions passing. Here as elsewhere I noticed how young the men are who are engaged in vast businesses.

"Professor Hale called to take me off to see a very rich man who is very anxious to immortalise himself in the same manner as Mr. Lick has done by building a great observatory. The owner of the millions is, however, hesitating on the brink, but Hale said he thought if I would raise my voice the thing would be done. I told him that I had no confidence whatever in the adequacy of my powers of persuasion, and I must say it was with some relief I learned the old gentleman was ill and could not be seen.

"You have all heard of the wonderful buildings of Chicago, but the strangest of all that I have seen belongs to the Hale family, and I was taken through it yesterday. It is fourteen stories high, and from top to bottom it is fitted out for doctors' consulting rooms. Now mark my words. In that one building two hundred and thirty doctors do business. Some doctors have suites, others have single rooms, and many have a room on the Box and Cox principle, each having it for one hour or two hours. Each room is provided with every convenience in the way of chairs and the like. Each doctor has a locker in the

room he uses in which to keep his instruments. There are in some cases reception rooms common to four different consulting rooms, so arranged that the patient can pass out and away from the doctor without returning through the reception room. The rents vary from £30 a year for one room, one hour a day, upwards. They have far more applications for rooms than they can supply, and to judge from the crowded state of the elevators a lively business is done. One floor belongs to the dentists. Over the way is a similar building with one hundred and fifty doctors, and close by is yet another with a hundred more.

"The next step was to call and make the personal acquaintance of Professor Burnham. Doubtless, my dears, you all know that he is the greatest double star observer now living. We saw him in his office, a man about sixty-five, with ready talk and keen glance. We talked much and long of his discoveries and work, and then of many other things, and then he took us to lunch at an Italian restaurant, and the 'lunch' proved to be a very ample dinner. Then I had just time for a brief visit to the Western Electric Company Works, where Judge Wait's son is employed, and where the telephone apparatus for the world is made. I was specially interested in the wonderful automatic machines which do the most complicated pieces of work, now turning up one cut of a piece of brass, putting a screw on it, and drilling a hole in it, and then putting forth a pair of iron fingers which carry the piece to another part of the machine, turn it round, and so place it that it can be acted upon by other cutters, and finished at the other end. One man can tend seven of these machines.

"I am now nearing Philadelphia, and from thence I go to Haverford, Pa., to stay with Brown till Christmas Day, when I give my fortieth lecture.

"I have had a great time indeed, but I am still heartily glad to think that no more than three weeks now remain before I sail for home."

"(New York, New Haven and Hartford Railway, en route for Waterbury, where they make the watches.)

"Saturday, January 4th, 1902.

"DEAREST FAMILY,

"The last collective letter was, I think, written on December 21st, when I was on my way in the 'Pennsylvania Limited,' a wonderful train from Chicago to Philadelphia, so now I shall try to give some account of myself from that time up to the present day, just one week before I sail for home.

"I went to Philadelphia with the object of spending my Christmas with Mr. Brown and his sister, but I need not tell you that though they were as kind as possible and gave me a very pleasant time, yet my heart was with all the dear ones at home, and the only time which I have had occasion to use the 'code' was to cable you all a very merry Christmas.

"On Christmas morning I went to church. Mr. Brown appeared in the choir, and at one o'clock we had our Christmas dinner of turkey and plum pudding. There were two other guests, both English. First, Miss Scott, who has been for twelve years head professor of mathematics at Bryn Mawr Ladies' College. She is from Newnham or Girton, and she has really wonderful mathematical ability. The other guest was Miss Smith, who is the matron of the hospital at Philadelphia. There were a threepenny-bit and a ring and a button in the plum pudding. The button came to Miss Smith, the 3d. to Miss Scott, and the ring to me. I rather think Mr. Brown, who helped, adjusted the affair.

"The next day, Boxing Day, December 26th, I spent in New York. It is a nice trip from where Major Pond lives across the Hudson River to New York. The city is so beautifully clean and bright. There is absolutely *no* smoke. The domestic fire must be of wood or of anthracite, but, generally speaking, it does not exist, the heating being done by the furnace in the basement, from which great tubes carry the external air duly warmed into the different rooms. Over the city there are numerous jets of steam from the engines, but these are not unpleasing. The only smoke I have seen here I saw to-day, but that was from a house on fire; not only was there smoke from the house, but there was still more from the fire engines. They are allowed to burn cannel coal, and wonderfully efficient they are. The fire was put out in no time. New York is certainly one of the sights of the world. It is spreading and growing in such a marvellous manner, and the continual sunshine makes it look its best. In the up-town, the newer residential part, the most gorgeous palaces of flats and 'apartment houses,' as they call them, are springing up. You can have no idea of the architectural splendours of these, and as to the Hotel Waldorf Astoria, it is about as much more splendid than the Langham, as the Langham is more splendid than the 'Bull.' I have not been in it, for it is said to be desperately expensive. I was asked to a great banquet there of the English-American Society, at which all the great orators were heard, and there were 500 guests, but unhappily I was engaged elsewhere, and had to decline. On the evening of Boxing Day I went to dine with Mr. and Mrs. Seton-Thompson. He is the author of 'Wild Animals I have Known,' and other books, and has had a great career as a lecturer. He is an Englishman from Canada.

The dinner was given in their beautiful flat, about ten stories up. There were many people there to whom I talked with much pleasure, especially Mr. Madison Grant, the Secretary of the new Zoological Gardens, which has just been started here on a magnificent scale. There were also New York notables, Mr. and Mrs. Samuel Untermeyer, who afterwards invited me to dine at their house in Fifth Avenue; but this invitation, as well as one or two others, which would have brought me into the very heart of the elect, I was obliged to decline. On Friday, 27th, I carried my bag to the cars from Major Pond's, went thence to the Ferry, thence across to New York, and then to the Murray Hill Hotel, a very nice place indeed, though it does not possess the glories of the Waldorf Astoria. I had arranged with Brown and Morley and Harkness to stay there for the 27th and 28th, so as to be able to attend the annual meeting of the Mathematical Society. This was to be held at the Columbia University, which is four or five miles away, though still in New York. It has a magnificent site on the bank of the Hudson River, which they tell me here rivals the Rhine in beauty, though, so far as my recollection of the Rhine goes, this is hardly the case. It is a splendid institution. The late president, Mr. Seth Low, himself built a library at a cost of £200,000, and innumerable other gifts have recently flowed in. Some anonymous person lately endowed a professorship of Chinese. The Chinese authorities were so much pleased that they are sending a collection of Chinese books and specimens as a donation to start the new Faculty of Chinese, and you will be interested to hear that Professor Giles has been asked, and has consented, to come out and give some opening lectures on the subject.

"But we merely went to the Columbia University as the most convenient place for the mathematical meeting. It lasted morning and evening for two days. I had my talk on Screws on the first day to a large and attentive audience. I listened to many of the papers. Miss Scott gave one of the very best, and did it admirably. It is astonishing to see the vigour with which mathematics is cultivated in this country. The most modern departments find eager followers here, and I was greatly delighted at the large number of men who could get up and speak intelligently on the most advanced subjects.

"I had long talks with Professor Williams, the geologist, and with Professor Gibbs, who has just had the Copley Medal given him. The chief attraction at New Haven is found in the wonderful palæontological collection. I had seen it before with Professor Marsh seventeen years ago. There is the most astonishing skeleton of a Claosaurus, a stupendous reptile as big as a rhinoceros, who sat on his hind legs and ate from his paws like a squirrel. There he is, limbs and hands all complete. There

are other wonders also. A portion of the sea bottom of the Silurian Period has been shown by dissolving away the lime, when all the organic remains have been replaced by silica. It is impossible to conceive the delicacy and wonder of this relic of the most early sea bottom. Then there are the wonderful foot-prints of the great Dinosaur, which walked like a bird. The place where he *sat* down is shown, and the marks of his skin, and then the marks where he put his front paws down to help him up again make a wonderfully realistic picture. Professor Beecher, who has done all these things, is a great artist.

"I made a good beginning of the New Year by a very early start on January 1st. The object was to get from New Haven to New York in time to hear a lecture from Mr. Seton-Thompson on 'Animals I have Known,' which was given in the Carnegie Hall at 11 A.M. Major Pond sent me six tickets for a private box, with the intimation that the next box was to be occupied by Mark Twain! I sent five of the tickets on to the Goodbodys, and some of them turned up. I was duly introduced to Mark Twain. He is a most striking-looking man, and we had a nice little talk. I told him how fond we were of 'Mr. Bixby.'* There was a large attendance at the lecture, mostly children. The photographs of the bears as they may be familiarly met in the Yellowstone Park were very interesting. Individuals are well known, and 'Old Fatty' and 'Little Johnny' appeared to be great favourites with the audience. Then there was the 'Tragedy of Lobo, the King Wolf,' which is really fine. I was glad to have been there.

"Friday, January 3rd, was a red-letter day from the geological point of view, for Professor Osborne had promised to take me over the magnificent collection of fossil vertebrates in the New York Museum. The fossils which have come from Colorado have thrown astounding light on evolution. I will here mention only two things. We have often been told that the rhinoceros and the horse are akin. I now find no difficulty in believing this, for he has shown us a fossil animal with many characters of the rhinoceros and the grace and agility of a horse. Then he has the skeleton of a Brontosaurus, which is over seventy feet long, a terrestrial or semi-aquatic animal. But what interested me specially was that several of the vertebræ have been gnawed and bitten, and there are the marks of the teeth of some carnivorous Dinosaur of the period. Even the Brontosaurus had enemies. Life is a great tragedy!

"I start for Detroit to-night. I hope to catch a flying glimpse of Niagara in the morning. Maybe I shall write one more letter, but this day week I shall be on the ocean."

* The pilot who taught Mark Twain on the Mississippi.

"ONE HOUR FROM PITTSBURG
TOWARDS NEW YORK,
"*January 9th*, 1902.

"*En route Pennsylvania, Limited,*
Pullman Vestibuled Train.

"MY DEAR FAMILY,

"This is the last of the collective letters, and I fear they have been a very dull series and have given only a very inadequate view of the intensely full and interesting eleven weeks of my American wanderings. I shall now resume my account from last Sunday, when I had some five or six hours of quiet in the Century Club at New York.

"*Sunday, January 5th*, 1902, at 6 P.M., I started again to the West for the eleventh and last week of my lectures. I reached Detroit, at the end of Lake Erie (look at your map, please), at midday. Of course at this season the lakes are so far frozen that navigation is impossible. In the summer the steamers form, I am told, the most delightful means of getting about this lake district; only remember the lakes are almost as large as good-sized kingdoms. I was told that more tonnage passed through the river at Detroit than in all the seaports of the United States put together. This astonishing statement is made true by the mighty traffic in iron ores brought from Lake Superior down to Pittsburg to the wonderful Carnegie works, of which more anon. I lectured in the Unitarian Chapel, and as soon as the lecture was over I hurried off to the station, for I knew it would take me all my time to get to Pittsburg by the next evening.

"I have been obliged to put my foot down as to the things I will see, or, rather, as to the things I *won't* see, and so I announced that I had *not* come to Pittsburg to look at pictures or to visit the observatory. 'I will admit at once the excellence of the pictures and the renown of the observatory, and so, as I require no further conviction on these points, I have come to see the fossils in the museum and the great Carnegie works.' The day was arranged accordingly.

"The museum is part of the great institute founded by Carnegie. You may imagine what it is when I tell you that for the superb concert hall a *permanent* orchestra of about thirty-five is maintained (the conductor is an Irishman), and they have just appointed an organist at a salary of 800 *pounds* a year (4,000 dollars). In the museum there is keen rivalry with New York and New Haven in the collection of fossils from Wyoming. They are shortly to have at Pittsburg the 'Hall of the Dinosaurs,' in which is to be the most superb exhibition of these monsters. The hind leg of a Brontosaurus is perfect in every bone, and as high as the ceiling. He was about *ninety feet* long.

A short time ago one of the New York papers announced the discovery of one of these huge fossils, and by way of illustrating the size of the brute, they gave a picture of a sky-scraping building with the leviathan pleasantly peeping in at the tenth story. Carnegie tore this out, wrote on the margin, 'Buy this.—A. C.,' and sent it to the curator. Instantly the curator started for the West, and found that, as it had been discovered by one of their men, the University of Wyoming claimed the animal. 'Name your price,' said the curator, and they made a bolt and named a hundred thousand dollars. 'Fiddlesticks,' said the curator. Then the curator found that the land in which the reptile was entombed was still public land, and he went to the Government and bought the claim, including the bones, for a trifle. He thought he had done a good stroke, but Carnegie said 'No, that will not do,' and he bade the curator write to the University of Wyoming to the effect that, fearing this wonderful treasure should be lost to the public, Mr. Carnegie had bought the land, and now presented it to the University. This produced the desired effect. The University now also did the polite thing, they accepted the gift of the land, but presented the bones to Carnegie, with a hint that they were badly in want of a library. The curator went back to the site, only to find that the geologist of the University had in the meantime made a foray and tried to dig out the bones, but so unskilfully that he did not get anything of use to him, while he spoiled the beast for anyone else, so that, as a local man expressed it, he 'would not give fifty cents for the whole blooming outfit!' The curator, Dr. Holland, told me that there is an immense area, hundreds of acres in extent, which contains a stratum of these mighty bones many feet in thickness. It seems as if there had been a bar across an estuary, down which the carcases floated, and the bones were deposited against this bar. They are all in the most hopeless confusion, so that specimens that can be of any use have to be sought elsewhere, in places where animals have died in conditions favourable to their preservation. Truly there were giants on the earth in those days!

"I could hardly be torn away from these wonderful things, and their most interesting curator, Dr. Holland, but Mr. Brashear's hints that we had much to do at last prevailed, and we went off to Mr. Brashear's house to lunch. First we took a look into his works. He makes some of the most perfect prisms and mirrors in the world. He has just completed a job for Lord Rayleigh of a plane mirror in which there is no deviation more than the thirtieth of a wave length, and his business is nourished by the fact that he makes the lenses and prisms for the new binoculars made by Warner and Swasey. As the latter firm were good enough to give me a present of one, I shall bring home in

this way a specimen of Brashear's work. He made the wonderful prisms Mr. Newall uses also. Then after lunch, where we met his partner and son-in-law, an Irish youth from near Belfast, we started for Carnegie's mighty works. There are several works in the great steel combine, but I specially chose to see the place where steel rails are made, as the automatic machinery has there been carried out to the utmost perfection. From the seven great blast furnaces where the ore is melted, the molten ore, a blend from all the furnaces, is run into the Bessemer converters, each holding fifteen tons; then in twenty minutes it is poured out as dazzling melted steel into moulds; these are carried off at once on a railway, the moulds are lifted off, and each mighty ingot, which is to make four rails, is tipped on a bed of rollers, which take it like a plaything backwards and forwards between powerful rolls, which squeeze it out into double, then it flies along without apparent aid as fast as you could run to another place, where the ends are cut off and it is cut in half. Then each of these halves, still tearing along, is run by the machinery backwards and forwards through the rolls till it is lengthened into the rails and a bit over. Then down come mighty saws trimming off the ends and cutting the double rail in half; on it flies to another place, where it is straightened, punched with the necessary holes, and put into a railway truck ready to be taken to market. I would have liked to spend hours in this wonderful place, where machinery does everything that once entailed human labour. A man standing at a bench with a few handles now controls these resistless machines. In the old days a man used to earn fifteen cents for rolling a ton of rails, now he earns one cent a ton, but gets more money than he used to. As I looked at the machine I found it easy to imagine where all the Carnegie libraries had come from. Night and day (Sundays only excepted) this interminable flow of rails goes on, and a corresponding torrent of dollars flows into the pockets of the owners. The various concerns in the mighty steel combine are said to be earning at present £60,000 *a day*.

"After a good-bye to Mr. and Mrs. Brashear, who have been most kind, I went back to the hotel. That was last night, and I had to make arrangements for an early start this morning. I had to leave the hotel at 6.30 to catch this wonderful train, the Pennsylvania Limited. I have been a little suspicious of the reliability of the people where these early starts are concerned. However, they called me all right at 5.45 by the simple dodge of ringing the alarm bell at the telephone. I had, however, awakened already, and then I had a nice carriage and pair to drive me to the station. But the old train was an hour late, and now we are an hour or more behind time. I am to lecture at Brooklyn to-night, and it will be another tight fit. However,

it is not of much importance, and Major Pond will be on the spot. I find I have forgotten to mention one point. On my way from New York to Detroit the route lay *viâ* Niagara, so in the early morning we crossed the suspension bridge over the Rapids, now containing much floating ice. Thus we paid a visit to Canadian territory, and then the train stopped, as it always does, for five minutes at a terrace over the Falls, just to give us a peep. The winter view was interesting, but it is not nearly so good as the summer. Of course we cannot get the best view from the train, but we saw the wonderful Horseshoe down which the river makes its plunge.

"And now my journey is nearly over. I am hastening to New York to sail the day after to-morrow. I give one farewell lecture in the afternoon at Columbia University, which will be the forty-eighth, and at three the next day the *Saxonia* sails.

"I have had a most interesting time; no very striking adventures certainly, but have seen much that has been pleasant and instructive, if only I can profit by it."

On his way home he wrote from the s.s. *Saxonia* to a friend on January 14th, 1902:

"As I approach the shores of Ireland my first thought is as to your mother. The last account I had was a more favourable one, and I hope to have better still when I reach home next Monday, as I hope to do. Perhaps I may get a letter at Queenstown.

"I have had a glorious eleven weeks. Every moment was full of interest, instruction, and entertainment of the highest order. Not for one moment did the time drag. It was always the other way, trying to get the Atlantic into a quart pot. When I am born again in a new sphere I intend to choose (if I have a choice) a globe of seven miles in diameter as my abode, so that I shall have some opportunity of learning something of my earthly residence. There is one thing, however, that I have not seen. I have been north as far as New Hampshire, and south as far as Richmond; I have been to the other side of the Mississippi; I have stayed in many houses, in hotels great and hotels poor; I have been entertained at dinners, at luncheons, and at receptions large and small. I have been in the Universities, the places of business, the observatories, the slaughter-houses, in steamers and in Pullman cars. I have shaken hands with many hundreds and spoken to many thousands. I have been doing this all the time and all day long (and often all night) for eleven weeks in the United States—barring two and a half hours in Canada—and yet the one thing that I have *not* seen is an *American!* I don't mean Red Indians! The American I have *not* seen is the tall, swagger-

ing, tobacco-chewing Uncle Sam of the stage and fiction. I have met scores of the most charming, well-bred, well-educated and cultivated people that this earth can show, but of the dollar-worshipping vulgarian that the American is reputed to be at home I know nothing, and I certainly could find nothing corresponding to the description in all my travels. Millionaires, of course, there are, poor things; they cannot help it, and they do their best to conceal the offensive nature of their misfortune. One of these reprobates will be a diligent Professor of History in a University, absorbed in his duties, delighting to render help to every scholar and with sympathy in all intellectual work, and work that is useful for the country. Another is a man who works quietly in his office as a merchant in a back street in New York, who delights to take a friend or acquaintance to lunch at his club, or to bring him home to dine at an elegant and most refined home in Madison Avenue, where he will meet the very nicest and best bred people that this world produces. Whether they are rich or not nobody knows or cares, and this same man may be silently giving away vast sums that nobody knows of, and building a superb Union building in the Columbia University! And yet a third. After your lecture is over, a little man rather shy, but most courteous, will ask the privilege of helping you on with your coat, and then propose to show you the way over to your hotel a couple of hundred yards distant. He will chat simply and frankly, and then give you his card, and say: 'I run over to Scotland every year, and this is the name of the place where I stay.' You look at the card. It bears the name of an historic Scottish castle, and is an invitation to the recipient for him and his to make that castle his home for as long as he likes between July 1st and October 1st! I have here sketched, or, rather, indicated the three millionaires whom at this moment I recall. They are, I believe, typical of the class!

"Carnegie I did not meet,* but I went to see his works. Recognising that the operations of social and natural causes have conspired with his superb individual talents, Carnegie has set an example to the millionaires everywhere. The chief anxiety of these people in America now seems to be to discover means by which they can deplete themselves without harm to the recipients. The wealth that is pouring into the universities all over the country is one of the consequences. Many times during my stay did the universities announce the receipt of millions. President Harper, of Chicago University, declared that he intended to collect £10,000,000 for Chicago, and he is in a fair way to succeed.

"In these universities it is not alone the superb equipment and the wealthy endowment which strike me as admirable. I was

* My father met him, some years later, at the opening of the Carnegie Institute.

still more astonished at the high character of the education given. Never again let anyone speak slightingly of the degrees of an American university. I speak only of mathematics, and I had ample opportunity of judging, for I attended the annual gathering of American mathematicians at the Columbia University of New York. The professors of mathematics are in the very forefront of the science. Formerly those who wished to study mathematics in its higher departments used to go from America to Germany. Now they can stay at home and find all they want. It was delightful to see a large room filled with young men most keenly interested in advanced mathematics. I believe the same is equally true in the other departments. In astronomy, it goes without saying, there is more work in that science done in America than in all the rest of the world put together. There are two high-class mathematical journals in America. It is doubtful whether there is one journal in Great Britain to which the same description can be applied.

"The sceptre of the world has gone to the West. That is certain, and yet the thought was always with me that this magnificent prosperity, intellectual and material, is only beginning. The valley of the Mississippi will play, perhaps, as great a part in human affairs in the centuries to come as the valley of the Nile in the centuries of the past.

"I have spent eleven weeks in America, and all the paper in this ship would not hold the account of what I have seen and heard in that most wonderful country. The astronomer sometimes wishes to see what another world is like, and when I took my first walk in New York I could not help saying to myself every moment that I had got there at last! I do not wonder at the pride Americans feel in their country and at their love of it. I gave forty-five lectures in various parts of the country. I got as far west as the Mississippi, and lives there the man that can cross that mighty river for the first time without some emotion?

"I cannot tell you of all the kindness and hospitality I received, and what I was able to accept was only a fraction of what was offered. All went well from first to last, and there was not an hour the whole time which had not at least three most interesting claimants, of which two had to be refused. The ease and comfort of travel in America strikes a visitor at once. Think of the dingy hole with a grate full of ashes and a spark or two of fire, with two gas burners, one of which won't light and the other is very dim, which is called a waiting-room in some of the best English stations. Visit a station here not merely in the great cities, but in scores of places, and what do you find? A palatial hall generally of white marble and often with beautiful mural decorations. Floods of electric light. Double glass

doors through which you pass, it may be from zero outside, into a genial summer warmth inside. White floors, spotlessly clean. Rows of clean and comfortable seats in abundance. Fountains where you may drink at will the purest of ice-water. Around are the windows at which you buy your tickets for train or Pullman. Newspapers are there, of course. Flower stalls are not wanting; and, as everywhere else, the barber's shop is there, where you can also have a Pompeian massage for your complexion if you think it will do you good. The railway carriages are most comfortable. They are all through on the Swiss plan, and nicely warmed. The fares are much less than with us.

"The Irish are ubiquitous! I heard the sweet tones everywhere. Galway was represented in a club porter at Boston; Dorset Street, Dublin, in the hall porter at the Institute of Technology; Tyrone in a majestic personage dominating the station at Philadelphia; Limerick in a governess in Pennsylvania; Wicklow in the guide to Pillsbury's mighty flour mills in Minnesota; Dublin youths own the mightiest carpet shop in New York, and I fear we must also acknowledge the leaders of Tammany, at last hurled from their usurpation at New York, as belonging to us."

CHAPTER XVI

A VISIT TO THE RIVIERA AND ITALY

IN the spring of 1895 my father and mother went for a continental tour to the South of France and Italy. They visited Paris, Cannes, Monte Carlo, Genoa, Pisa, Rome, Naples, Rome, Florence, Venice, Milan, and Lucerne. They were only away from England for a short time—about three weeks—but into that period they crowded as much sightseeing as was possible.

Departing from his usual custom, my father kept a diary during part of this tour. The first entry is dated Sunday, March 30th; the last is dated Saturday, April 13th. Unfortunately, the journal came to an end during the second visit to Rome, so that no record remains of what struck him most forcibly in Florence, Venice, or Milan.

I do not propose to publish this diary at length. Much of it is concerned with ways and means of travelling, hotel accommodation and the like. Nevertheless, it contains some passages which show a remarkable power of observation and description. Another reason why I have refrained from literal transcription may be mentioned. When discussing the publication of his "Reminiscences" a year or two ago, I well remember my father saying: "I think it is a mistake to publish diaries of travel. They are so much like what can be found in a guide book. I always skip all such matter when I come across it in a biography."

In making excerpts from the diary I have borne this precept in mind. It will be for the reader to say whether the following memoranda resemble anything which is to be found in an ordinary guide-book.

The gardens at Baron Rothschild's villa at Cannes appear to have made a deep impression upon him:

"Beneath the Hôtel Belle Vue is the villa of Baron Rothschild. We went into the garden as far as intruders might

venture with decency. I never saw any mass of colour more gorgeous than the tulips of deep crimson at the entrance. This is a garden of artificial beauty alone."

Features of Cannes dear to the heart of the botanist are thus described:

"One of the most interesting features of Cannes is the root which the eucalyptus has taken. The tall grey stems of these trees are invariably to be seen playing the same part along boundaries and the like that rows of beeches or elms do at home. But although they are so far naturalised here as to be able to dispense entirely with protection, yet the frosts—and they have frosts at Cannes—wound them seriously. Many branches were badly frost-bitten by the severe winter which was just over. It does not seem, however, that the gum trees can be easily killed; in fact I should say that they would be more likely to oust all the native trees if allowed to do so. The palms had not suffered from the frosts, but at the same time they always appear to have been carefully planted and tended. They are all plainly exotics in this country. They would be at home on the other side of the Mediterranean, but they are not established here. To see the prickly pears growing out of doors was also very interesting to a new-comer. But plainly their existence here is also on the same frail sort of tenure as, let us say, the shrubby veronicas are in Ireland. In a few very sheltered places these plants looked plump and hearty, but in other places they had evidently suffered severely from the cold. Although the plants had not wholly succumbed, many of their lobes were very sickly."

Having received an invitation to visit Mr. (afterwards Sir Thomas) Hanbury's famous garden at La Mortola, near Mentone, he decided to drive there and back. His experiences when crossing the various frontiers are thus recorded:

"Shortly after passing Mentone we reached a French sentry stationed on one side of a deep and very narrow ravine. This is the boundary between France and Italy. On the French side of this ravine there is a V-shaped mark on the rock to indicate the exact point. Our coachman explained to the sentry, or *douane* officer, that we were returning, saying that we were only going to La Mortola, and with a nod of assent he allowed us to pass out of France and into Italy. The road then ascended for about a quarter of a mile across a strip of what

appeared to be a sort of No Man's Land. At the top we came to the Italian *douane*. Here we were first gruffly stopped by a subordinate, and then the *douane* officer appeared and asked the *cocher* for his passport. In it were set down the carriage and horses; he carefully looked over the horses, and finding that one horse (not having a blind eye) was *not* the horse mentioned in the passport, he thereupon looked very serious. Other officials came out to see whether this invasion of the Kingdom of Italy by a pair of horses with four eyes could be tolerated, when the passports had merely permitted three equine eyes to belong to that particular equipage. Our *cocher* had to go inside and sign certain declarations. At first I thought we should not be allowed through at all, and, indeed, Miss Hanbury told me afterwards that, according to the rules, we ought not to have been allowed in. All the time the *douaniers* never looked at us in the carriage, nor did they ask a question. I wondered whether they would examine my eyes next!"

Another passage of interest describes a visit to the Casino at Monte Carlo. I am positive that during the whole course of his life my father never "put money on a horse," or staked a penny on a gaming-table. One of his objections to betting and gambling was that the "bookie" in the one case and the "bank" in the other were always bound to be the winners in the long run. I was not, therefore, surprised to find, on perusing this journal, that he risked no money on the tables. But he did indulge in the luxury of a visit to the Casino, where the application of the law of probabilities evidently presented attractions to the mathematical mind:

"In the evening we went to the Casino. We had to get our ticket of admission at the office on entering. I left my hat, coat, and umbrella in the office, and then we entered a magnificent hall, from which we passed into the superb series of saloons where the gaming-tables were placed. I was at once reminded of my visit to Ems, Wiesbaden, and Homburg thirty-three years ago. I had seen nothing like it since. The majority of the players at the roulette tables were dealing in five-franc pieces. But some were playing pretty deeply. I saw one man who at one stake lost £160 or so in gold pieces, and altogether he must have lost over £200 during the few minutes that we watched. At the *rouge et noir* card-tables

only gold pieces are allowed. All the many tables were crowded, and I think there were quite as many, if not more, women players than men. On the average I should say that the bank wins about a tenth of the stakes. We saw no heavy wins, but one old and not bad-looking gentleman, who had several little piles of gold before him, seemed to be winning, and twice while I was looking the little piles had grown so much that he handed over a number to be transformed into notes which he deposited safely in his pocket. He seemed to be going, if not exactly on the doubling system, yet on something like it. But, of course, everyone must lose in the long run. This whole place is saturated with the gaming spirit. In the hotel are notices to the effect that all meals must be paid for on the spot, that no cheques will be taken, that hotel and other bills must be discharged instantly they are presented. This shows the kind of customers they have. The whole state of Monaco lives solely on the profits of the gaming-house. The conversation one hears turns solely on gambling in gold, mine shares, and the like."

On the following evening he paid a second visit:

"In the evening I went over to the Casino. The play was an interesting sight. To-night I saw a man win heavily—£80 three times running, and then he lost some small sum, and then won £160. As before, the greater number of players staked but small sums. I heard that some of the old French harridans who infest the place will snap up the winnings of any beginner when they get the chance. I heard no dispute—not a sound, in fact, came from any one of the seven or eight tables, except the voice of the croupier. There were also but few sightseers. Those that thronged round the table were all players, most of them *habitués* who occupy the chairs and carefully mark on their cards how the tide of fortune runs. But I saw, for example, one quiet-looking gentleman move silently up to the table and just slip in his ten napoleons, and then, when the red card turned up and his coins were raked away, he just moved off again. There are thirty-six figures and o. If a stake is laid on a number, and that number turns up, the player receives thirty-five times his stake. If he bets on two numbers, and one of them wins, he gets seventeen times his stake. If on four numbers, and one of them wins, he gets eight times his stake. The rate of profit of the table is not high.

I don't think at roulette it makes more than 3 per cent. of the money staked. It is an instructive demonstration of the truth of the Theory of Probabilities, that, having only such a slight margin in their favour, they are nevertheless able, in consequence of the magnitude of their transactions, to make such vast profits; for I am sure that £30 at least is staked every throw; probably double would be nearer the mark; I have seen upwards of £200. The table must clear on £30 about £1 on the average, and as they make about fifteen throws an hour (at least), this means £15 per table per hour, and for the day's work of eleven hours this means £165 per table; and as there are seven or eight tables it is plain that the daily profits cannot fall short of £1,200 or so. Indeed, I should not be surprised if three times this sum was often realised. But 3 per cent. is certainly a very moderate charge for the table to make, so that those who like gambling in this way can do so quite as cheaply as on the Stock Exchange, and they have also the means of judging here whether they are fairly treated, which the gamblers on the Stock Exchange have not. So, while South African shares and horse-racing occupy so much of the attention of the British public, I do not think it rests with them to say a word against the Casino at Monte Carlo. It is at least honest gambling."

His interests at Monte Carlo were not, however, confined to the Casino:

"The most beautiful palm that grows in this place is the *Phœnix canariensis*. Its foliage is splendid, and it seems hardier than the *P. dactylifera*, which seems to suffer in the hard winters and is not really acclimatised, a fact very evident from the circumstance that the dates do not ripen. But a very striking palm, with a smooth stem like a gigantic elephant's leg, is the *Pritchardia*. Then there are arborescent figs, *Ficus macrophylla*, which are specially good, and also arborescent *aralias*; some of the latter had tufts of berries just like the ivy."

At Nice he made the following entry:

"*April 3rd.*—The residence of the Queen is not a very striking place. What interested me far more was, that just opposite the front gate are the remains of a Roman amphitheatre. The ruins are well preserved. At one place the seats up to the top are still there. Many of the arches are intact. I saw in the building those horizontal layers of red tile which

I remember in the Pharos at Dover. What builders they were! There is the mortar just as the Romans put it in 1,500 (?) years ago. This will be a good preparation for the Colosseum. I am not much given to emotion, but I think I felt a little in standing in the middle of the arena where gladiators fought and died, and where the Christians were given to the lions. F. was satisfied with a view from the carriage, and so she missed what I saw, namely, the two small sons of Princess Beatrice driving out."

The visit to Pisa recalled memories of the great astronomer-mathematician who uttered the famous words, *E pur si muove:*

"First we went to the Leaning Tower. F. was contented with but a small part of the ascent, but I of course went to the top. There is a splendid view, from the snow-covered mountains on one side of the plain to the sea on the other. I was amazed at the flatness of the plain and its fertility. It is not easy to get to the edge of the tower so as to look over. Galileo must have had some framework erected on that memorable occasion. This is all duly set forth on the inscription at the base of the tower, which I copied into my pocket-book:

GALILEUS GALILEJUS.
Experimentis E Summa Hac Turri Super Gravium Corporum
Lapsu Institutis
Legibus Motus Detectis
Mechanicen Condidit
Ingentibusque Suis Posteriorumque Sophorum Inventis
Prælusit.

"The true theory of the Leaning Tower seems to be that the sinking commenced while the building was in progress of erection, and that the architect then endeavoured to mend matters by giving it a little turn in the opposite direction. Viewed under the blue sky of Pisa, this is truly an exquisite object, but it is not alabaster white. A large part has a yellowish tinge not over-pleasant to the eye.

"The cathedral at Pisa, close by, is, of course, a lovely sight, but it was the famous lamp of Galileo which interested me most. The attendant guide assured us that it was 'always' swinging."

It has been noted elsewhere in this volume that my father took a keen interest in geology for its own sake. But he was also of opinion that he who would study the heavenly bodies must wander in those misty regions where astronomy and geology meet, and that certain celestial phenomena can only be explained by reference to the history of our own planet, dating back to the time when "the earth was an infant at play." Vulcanology was the branch of geology which interested him most; "Krakatoa, the Mighty Volcano," was one of the most popular of his lectures. In these circumstances it is not surprising to find that he paid a visit to Naples and its environs, and that Vesuvius, Pompeii, and the Phlegræan Fields were replete with interest for him. The impression made upon him by his visit to the Mecca of the geologist is recorded in the diary as follows:

After describing (in no very glowing terms) the drive along the coast from Naples, he proceeds:

"*April 8th.*—At last, however, Pompeii was reached, and at the entrance we dismissed our carriage—a bad one it was, too, for which we had been charged a pound. There was a restaurant at the entrance, where we had lunch, and then we paid 2 lire each and entered Pompeii. A guide was at our disposal, but in Italy I found that guides are worse than useless; they are always bent on some sinister object with the view of extortion, and they contrive to show you as little as possible of the things you most want to see. C. had warned me not to take a guide at Pompeii. However, one is included in the price of admission, and though he showed us no doubt a few things we might have missed, yet we should have done better had we said to him at the outset: 'Va Via!' which is a wonderful charm for getting rid of a beggar or any other similar tormentor.

"But though we could not feel that we had seen the wonders of Pompeii in all their fullness, yet we had a day that will ever live in our memories. It was indeed a realisation of my lifelong wish to take a walk through that city which was preserved to us by what seemed to be its destruction. First let me say that it is hardly correct to speak of Pompeii as being covered with ashes. The materials by which it was entombed have the appearance of volcanic pumice or similar material.

"On entering we were first shown into the museum. Most

of the really choice works of art and curiosities which admitted of transportation, have been removed to the museum at Naples, which we were afterwards to visit, but there was much in the museum at Pompeii to interest us. The first objects I noticed were the remains of the locks to the doors. Not wholly unlike a modern 'Chubb' were the facsimile models which had been formed of some of them. Perhaps the most interesting objects were the casts of the few bodies which were found. The bodies having disappeared, the hollows in the 'ash' were filled with plaster, by which means striking statues have been produced. One of the most effective was that of a man who, in fleeing from the city, carried his money in gold coins in a belt around him. The belt is there directly under the cast, and the veritable coins are, we were told, preserved in the museum at Naples. The cast of a woman who had fallen on her face is a graceful figure, and there was another pair which the guide said were mother and daughter, though how he knew this did not appear. The cast of a large dog was interesting also. Then many loaves of bread were to be seen which age had transformed into charcoal, but their shape was much the same as the loaves now made in Naples. Many vases and similar objects were also to be seen, but these we were told were much inferior to the specimens brought to the Naples museum.

"Then we commenced our tour through the streets. They were paved with ashlars, as the streets of Naples are now, but they were so narrow that the cartwheels had worn deep ruts, in some cases, I believe, fully five inches deep; this at once speaks, as do many other things in the town, of the great antiquity of Pompeii. History, indeed, tells us that it existed for nearly four hundred years, and it is believed to have lasted much longer. The narrow streets were crossed by stepping-stones, the tops of which were flush with the sidewalks. Then we went into many of the houses; for instance, into the banker's, where, in mosaic on the doorstep, was the inscription: '*Salve Lucrum*'—Welcome Money. The shops were numerous, and there were the jars in which the wine and the oil were preserved. Mills for grinding corn were to be seen. At the corners of the streets were fountains. The water often appears to have issued from the mouth of a figure, and the way the orifice was worn testified to the antiquity of the foun-

tain, as did also the worn marks on the edge of the fountain where thirsty men placed their hands when getting a drink. It was very interesting to witness, so to speak, this superposition of one antiquity on another. Then, too, we visited the baths, in which there was a vaulted roof. As well as I remember, this was the only case in which the roof withstood the weight of the ashes under which Pompeii was buried. The baths are most elaborate. There was the seat on which the bathers sat, the receptacles for their clothes, the hot baths and the cold baths—and even the Turkish bath, where there was an inner lining to the room, leaving a space of a few inches in which the hot air circulated. I was amazed at the plumbing work of the Pompeians. The pipes appeared to be formed of lead rolled and brought together on the edge or overlapped. Instead of the wiped joint which the modern plumber produces, his Pompeian predecessor was only able to make a joint in a very cumbrous manner. I saw a few mosaic pavements with figures of animals such as I have seen at Boroughbridge. We went, of course, into the house of Glaucus, but did not see the memorable *Cave Canem* inscription. We saw the interesting wall paintings and the disposition of the rooms in the building of a wealthy and luxurious Roman noble. In many of the courts and houses the statues were still left, and truly graceful and beautiful objects they were. Sometimes we saw marble troughs or marble tables; sometimes little niches in which beautiful mosaic made a becoming surrounding for a beautiful statue. Of special interest was the writing on the walls referring to pending elections. Sometimes, I must add, objects could not escape our notice which it would not be seemly to describe. Then we saw the great theatre and the smaller theatre, and adjoining it we were shown what are said to be the barracks of the gladiators. But we did not see the amphitheatre, which lies at a little distance. About two-fifths of the whole area of Pompeii has now been uncovered, and the amphitheatre is in a detached part. It was specially interesting to visit the actual spot where the excavations were in progress. They were digging down into a chamber with wall decorations. Many of the objects found are broken, not, we were told, by the picks of the workmen, but by the falling in of the roofs of the houses—quite an adequate cause, no doubt. Unfortunately the work which we were watching was only at the top

of the room, and of course it would be at the bottom that objects of special interest would be found. But it was pleasing to see the gradual uncovering of a piece of mural painting in bright colours which had not seen the light for nearly 2,000 years. It would take many hours and many visits to see the whole of Pompeii. Baedeker would be better than any local guide, though no doubt the guides do show some few things. Our man seemed to be in a terrible hurry to get us through and get it all over.

"We paid a visit to Herculaneum on our way to Pompeii. That town was first covered with ashes, which seem to have been consolidated by water, and then the whole place was sealed over by lava. We saw the well by the sinking of which the existence of Herculaneum beneath the ground was accidentally discovered. We explored the theatre by the dim light of a candle, but there is little of interest in comparison with Pompeii. I believe that Herculaneum was really a far greater place than Pompeii, and there can hardly be any doubt that there are many treasures buried there. But excavations do not seem possible on any very extensive scale, as another town lies on the top. The papyri which were discovered have been brought to the museum at Naples."

On the following day my father paid the long-wished-for visit to Vesuvius:

"After a drive of six or seven miles along the same route as we followed yesterday to Pompeii we turned off to the left, and then we ascended, still on the same wonderfully paved road, until we reached a height where there was a splendid view of the Bay of Naples. I think the Bay of Dublin, in the mere matter of scenery, has nothing to fear in the comparison. Four hours brought us to the funicular railway. After lunch we took our turn as members of a party of ten for the steep ascent in the car. There were altogether about one hundred and fifty on the expedition this day, so that the place was pretty crowded. However, all were duly attended to. The funicular is nearly a mile long up the cone. The ashes were blown about by the high wind so as to create a dust which was very troublesome. Indeed, a pair of goggles would be necessary to enable the ascent to be made comfortably. When, in about eight minutes, we reached the top we were pounced upon in the dust storm and the high wind by the yelling gang of miscreants

and beggars that infest all Naples and its vicinity. These fellows had ropes and straps, and bawled out that they would haul you to the actual summit for two lire. Of course, their services were perfectly unnecessary. Cook has provided guides at the top; moreover, there is a broad pathway over the cinders. The wind was blowing so as to carry the column of steam and fumes away from our direction, but we soon got whiffs, though I must say the sulphurous smell was not very pronounced. Gases and steam were coming from small holes around, and two or three I tried were so hot that the hand could not be kept there. F. had found the ascent in the funicular enough for her, and she remained in the shed at the upper end until the rest of us came back. I made my way by myself, for my travelling companion, Mr. Barton, got separated from us in the ascending cars, and we only met later. A few minutes brought us to the edge of the crater. There was a basin-shaped cavity perhaps half a mile across, and on the far side of it there was much yellow and bright orange visible. The smoke and ashes were discharged from a cone which was at the side. The top of it was above our heads, so that we could not look into it. The cone is a new one, having been developed within the last six months. We were told that the mountain seems to be threatening an outbreak of considerable magnitude. While we were there, there was a rushing sound, and a large number of stones were shot up I should say thirty feet above the crater, and tumbled down quite as near to us as was pleasant; some of the stones, or blocks of pumice, or whatever they were, were visibly red hot even on this splendid day. I gathered a few specimens to bring home. We were rather hurried, and the driving wind, charged as it was with particles of cinder, made the sojourn very unpleasant. I should like, however, to have spent a couple of hours there at my leisure. The fact is that the way to profit by a visit to such a place as Naples is to spend the whole vacation in its vicinity. Use the first visit in getting a general impression and in learning the rules and practices by which the guides, as they call themselves, swindle, mislead, and frustrate you in every possible way; and then pay a second visit with a relentless 'Va Via' to all guides and beggars of every description. They are always an intolerable nuisance.

"The various lava streams are of much interest. I was par-

ticularly struck with the curious form the lava occasionally assumes, like the gnarled roots of trees. Various impressive pictures were also given of the fluidity of lava. Looking down from above, it could be seen like great branching streams spreading out on the plains below. From the top of the mountain it was indeed easy to see how such a comparative trifle as the inundation of Herculaneum was accomplished. Nor does it seem unlikely that other inundations might ensue which would submerge much of the present suburbs of Naples. In the frame of mind engendered by a drive through these streets of Naples, it seemed hardly unreasonable to wish that such a consummation might be effected.

"On our way down from the mountain we stopped at the Observatory. It seemed to me a very poor place. The instruments were in charge of some person who did not seem to understand much about them. The building is, however, a splendid one, and it seems a pity that such a place should not be well worked. Of course, I need hardly say that it only exists for the purpose of studying the earthquake phenomena. The seismometer rested on springs and stood simply on a deal table. Our drive back was tolerably pleasant. We saw the great P. & O. steamer—I forget her name—which was blown ashore a few weeks ago, and in that tideless sea has not yet been got off. Then back to table d'hôte and bed. There were plenty of people in the hotel disposed to be friendly, but after so many hours in the open air sleep was acceptable.

"We took a peep at the light from Vesuvius before going to bed. Of course, I need hardly say that in the present state of the mountain the so-called flames seen from the crater are merely the reflection of the incandescent materials from the matter which has been projected aloft."

"*April* 10*th*.—The first part of it we devoted to the museum at Naples. It is an admirably arranged structure. Of course the chief interest centres in the Pompeian collection. There are brought together all the choicest objects which could be transported from Pompeii. There are to be found the small objects, the coins, and the medical and surgical appliances. There are to be seen many bottles of Pompeian oil and wine. The collection of glass truly astonished me. There are the bedsteads, the vases, the grains of corn and other cereals, and multitudes of other objects too numerous to mention. Many

of the best frescoes are exhibited here. But the colours have faded. Indeed in any case the Pompeian frescoes do not represent any very exalted style of artistic development. The Romans were mechanics and engineers, but not artists, and the choice works of art were brought from Greece.

"In the afternoon we went by train to Pozzuoli, the Puteoli of the Romans, where St. Paul spent seven days. This was an exceedingly interesting trip, and would have been a perfect one on this exquisite day except for the intolerable nuisance of the guides. I promised one of these miscreants 1½ lire, and his whole object was to drag us off to things which we did not want to see and to get us to 'try the wines,' and, in fact, to frustrate us generally. We missed much that we should have seen, owing to this scoundrel. Of course the best way would be to make one visit with the guide and then to make another privately. In the only places where his services would have been useful he was not forthcoming. But, all the same, we saw much. The first thing was the Serapeum. Of course I had been long familiar with the Temple of Jupiter Serapis, in the frontispiece to Lyell's 'Principles of Geology,' but it was, indeed, interesting to see these celebrated columns with the holes bored by the shells. The lower part of each pillar was protected by the ashes which had fallen around it, so that when the submergence took place it was the intervening zone which was attacked. Then when the land rose again, the whole was brought out of the water. Next we went to the Solfatara. This is one of those craters in the Phlegræan fields to which I have so often referred in my lectures. The entrance fee is, as usual, half a lira. We entered a circular area filled with undergrowth and surrounded by a range of cliffs. The soil is largely of white material, used for cement in many places, and hot air and sulphurous vapour are breaking out. At the entrance of the cavern there is a great volume of sulphurous vapours rushing forth, and for a few coppers a man stoops down and goes in and brings out specimens of sulphur crystals and minerals almost too hot to touch. Then another man takes a big stone like a cannon-ball and bangs it down on the ground. It is supposed to show the internal fluidity of the earth by the hollow resonance and the peculiar trembling that is experienced, but I cannot truly assert that the evidence was quite convincing. Here, again,

the wretched guide misled us, and prevented us from seeing certain caves we much wanted to visit. His little game was to get us to buy some of the 'very good wine' which was to be had there. But it was quite plain that we were here actually walking over the floor of a crater which had been active once, and to all appearance might easily become so again.

"Then we went to the third of the sights at Pozzuoli, namely, the amphitheatre. The aim of the guide was to induce us to go to Baiæ, where we did not intend to go, so at the amphitheatre he said his duties were at an end, and I gave him the sum agreed on, and half more, and off he went. It will illustrate the cussedness of these gentry when I say that the amphitheatre was the one place where a guide would have been useful. His services were supposed to be included in the admission of 1 lira each, but, of course, in conformity with Neapolitan practice, directly we had paid there was no guide forthcoming. We had to grope our way round as well as we could. It is truly a splendid amphitheatre—not, of course, nearly so vast as the Colosseum, but it would certainly seat 20,000 or more spectators. I was amazed at the highly elaborate structure of the part beneath the amphitheatre itself. It was honeycombed with great corridors, with the dens for the wild beasts, and with trap-doors through which they could be shot up into the amphitheatre, either to kill the Christians or to be slain *coram populo* by the gladiators. Amphitheatres are abundant; this is the fourth that I have seen in Italy.

"As we stood at the station a man offered to *drive* us back to Naples—seven miles—for 2 lire; so we closed with him, and had an interesting trip home, along the shore for the greater part of the way. A range of hills dividing us from Naples was pierced by a long tunnel. It was lighted with lamps in the dark part, and at the middle was an elevator by which ascent could be made. There was a tram-line also through the tunnel, and a rich Neapolitan odour pervaded it from end to end. A quiet evening closed a pleasant day."

"*April 11th (Thursday)*.—We went down to meet Mr. Bidder at the Aquarium, the celebrated Zoological Station at Naples. This place interested me much, and I had the pleasure of being introduced to Dr. Dohrn, the illustrious director; and indeed he may well be proud of the 'Station' when he is able to say, as he did, that half of the biological work done all over

the world is done here. This is a wonderful degree of success and made our visit there one of much interest. Mr. Bidder is one of their most diligent and successful students. He has worked at 'Sponges,' and is said to know more about them than any man living. The Station was founded by Dr. Dohrn, who had about £3,000 of his own to start with. After much negotiation the muncipality of Naples gave him the site in the gardens on the sea front. But the £3,000 was not sufficient for the erection of this splendid place. He was on the brink of failure and despair, when Balfour and Foster and some others in Cambridge came to the rescue and provided £1,000 to help a little further. Then I believe the German Government gave £4,000, and I believe the Italians gave something; and in one way and another the Zoological Station at Naples became an accomplished fact.

"To provide the current expenses of £7,000 a year, tables are let to different countries or institutions. Cambridge, Oxford, and the British Association each pay the sum of £100 a year for a table. Each of these bodies can then send a man to work at the table. At present the Cambridge table is worked by our old friend Laurie, of King's College. He spent an evening with us at the hotel. Working at a 'table' means having the whole resources of the place at your disposal. Boats dredge and bring in the material, and there are tanks, chemical and photographic laboratories, and libraries, so that all biological researches can be carried on in the most advantageous manner. There are, I believe, about forty tables, but they do not defray all the cost. The balance is made up by subscriptions from various governments. Bidder explained to me that the special advantage of the Station lay not so much in the fact that it brought the resources of the Mediterranean to naturalists, as that it had now such an international character that all biological workers there met each other, or at all events heard of each other. It is, indeed, a biological museum in the highest sense. It illustrates the value of an autocracy. Dr. Dohrn is the master of everything.

"The Aquarium is an appendage to the Station; it occupies the ground floor, with apartments overhead for the scientific work. But of all the aquariums one has ever seen or heard of, there is none like this. Nor is this to be wondered at. There is a twofold reason. In the first place there is the Bay

of Naples, with all the resources of the Mediterranean; and then above stairs is the ever-active band of forty of the most eminent biologists in the world engaged in the study of marine creatures, ever stimulating the capture of new and interesting specimens, and seeing that those which are exhibited shall be properly tended.

"As to actual fishes, I did not see anything which impressed me so forcibly as the muræna, or Roman eel. This was a great delicacy in the time of the Cæsars, and we are told that they were kept in ponds and specially fattened. They are like congers, with a deeper back fin and elaborately marked with golden lines. They live sociably with a few congers, and seemed to delight in staying with the greater part of their bodies concealed in old pottery and drain pipes, which were provided for the purpose. I would far rather eat a conger than a muræna so far as looks go. There were several large mullet and other fish, and an electric torpedo, which is common in the Bay. One of these creatures is always available for visitors to experiment on. Mr. Bidder says, with obvious truth, that the source of the electricity is in this wise. Under ordinary circumstances it is an electric current which gives the muscular stimulus; and, generally speaking, of course most of the energy developed is muscular energy, but under certain circumstances the energy developed is mainly electrical. Natural selection might obviously produce this as a development, to a monstrous extent, of an agent which in a much less developed form had fulfilled a totally different purpose. In many of the tanks there were remarkable molluscs. Chiefly did I notice there gigantic whelks, or creatures of that description, whose shells are very familiar. They seemed to thrive. There were also many kinds of sea urchins which appeared vigorous, and some of the feathery starfishes were wonderful. There were few living corals, the waters they inhabit being too deep to be represented in the Aquarium; but there was one beautiful orange coral which flourished. Bidder also showed us many sponges, in which we could see the currents of water flowing in through the small holes and out through the large ones. The tanks were, indeed, filled with marvellous objects. I can only mention one or two of the pelagic animals. One of the most striking was a remarkable *beroë*, the action of whose cilia was like pearls of light running along his

meridians. Then, too, there was the Basket of Venus, a lovely delicate transparent creature. These live but a short time in the Aquarium. To enable them to be seen they are placed in large glass tubes six or eight inches in diameter, which stand up vertically in the tanks.

"After our visit to the tanks was over, we had only a quarter of an hour for a run through the great biological laboratories. There we saw Laurie at his work—upon annelids, I think; and then we returned to the hotel, and off to the train for Rome."

To judge from the diary, the famous Baths of Caracalla were the chief object of interest in the Imperial city. Under date April 13th my father wrote:

"In the afternoon we went to the Baths of Caracalla, a truly imposing structure, larger than St. Peter's. It must have been gorgeous in the extreme. The interior of the great hall, the *Sudatorium,* was supported by majestic columns of porphyry brought from the eastern Egyptian deserts. But some of the Popes, wanting porphyry to decorate St. Peter's, pulled down these columns—and with them the roof of the mighty bath. Even that they could not do except in such a bungling manner that they killed eighteen men. The roof was made of concrete, and gigantic blocks of it are to be seen. The secret of these colossal buildings is that slave labour was employed. The slaves captured in war were worked to death if necessary in these huge works. But the Romans must have been wonderful engineers and architects, and must have possessed marvellous skill in organisation to apply all that unskilled labour to the construction of such wonderful edifices. It seems hard to believe how merely wood fuel (and, of course, they had no coal) could have been adequate in maintaining the necessary temperatures for a *Sudatorium* in chambers rivalling cathedrals in magnitude. It is stated that 1,000 people could use the Baths of Caracalla at once. Around it were gymnastic grounds and music-rooms; and it seems that all were free."

CHAPTER XVII

SIR ROBERT AND THE GAME OF GOLF

SIR ROBERT became a golfer in or about the year 1892. He first joined the University Golf Club, which at that time had its links on Coldham Common, Cambridge, but he subsequently went to Royston, where he soon became a familiar figure on the heath. He used to say that golf was the only outdoor game which a one-eyed man could play, as the act of hitting the ball made no demand on the faculty by which the two eyes judge distance. He was what Bernard Darwin would call a remorselessly steady player, and many is the time he beat the man with a low handicap.

Amongst those who used to play golf with him considerations of space will only permit me to mention four. The first of these was his brother-in-law, Mr. L. E. Steele, with whom he played at Royston every summer for eighteen years. He also played with the Rev. F. Brindley, a son of the head master to whom allusion has been made in the early part of this volume.* "Fred" Brindley was a constant and ever-welcome visitor at the Observatory. He joined in many a game at Royston. Here is a characteristic letter written by my father to him (July 2nd, 1902):

"It is very good of you to have remembered the birthday. Yes, I am sixty-two, and as I took 130 to go round Royston when I was fifty-four, and as I only take 104 now, it is easy to work out that by the time I am ninety I shall have lowered the record on Royston Heath! Is not this interesting?

"We are going to spend a few weeks at Cromer in the autumn, and then I shall do my best on the links there."

Another golfing friend was Mr. Arthur Barker, F.R.C.S. He was, and I believe still is, a member of the Royston Golf Club, and my father, coming over from Cambridge, used to meet him there for many a pleasant game. The families of

* See p. 19, *ante*.

Barker and Ball have been intimately associated for many years. Two letters which he received from my father show that Mr. Barker was something very much more than a mere golfing acquaintance:

"R.M.S. *Saxonia*,
"*January 14th*, 1902.

"I am returning from America oppressed by the feeling that the one opportunity of my life has been lost!

"In the Mississippi, near Davenport, stands an island of 1,000 acres preserved by the Government, and still in its primæval simplicity. The only thing that has been permitted in the way of interference with the natural beauties of that island is the formation of a golf course. I was there. I saw the island and I was invited to play, but like Mahomet when he looked upon Damascus, I refused, and for the same reason: 'I know one paradise' [Royston, fare, 1s. 5d. from Cambridge.], 'I will not look upon another.' If I had not been driven by a slave driver to catch a train, I am afraid Mahomet's reasoning (which has only this moment occurred to me) would not have prevailed. No, I didn't play a game all the time!

"But I had a magnificent trip from first to last. I caught all my trains, gave all my lectures (some forty-five), and gathered up all the time all the entertainment and instruction I could. I have never spent an equally busy period of instruction and interest. The kindness and hospitality of the Americans was boundless, and, I think, I may say I have seen every side of American life from the far West to the Fifth Avenue. It will take twenty rounds at Royston to tell you of my wanderings, of the places I saw and the people I met. The conclusion I have come to is that Britain may put up its shutters! We are beaten to nothing not only in trade or wealth (I don't care about that), but in science, education, and wholesome life and progress!"

In 1905 Mr. Barker had invited Sir Robert to make a joint golfing holiday with him. He received the following reply (April 2nd, 1905):

"There is nothing I would enjoy more than the Cruden Bay trip and with you.

"Not to mention the excellent company, the time would suit me, the golf would suit me, the tariff would suit me, and I know I should like the place, and the porridge. I don't want any whisky and they don't provide it, you tell me, so the thing seems ideal. There is only one difficulty, but it is a fatal one. We are now, as you know, living a life, and a very happy life, too, as Darby and Joan, as the young birds have flown. I am obliged to leave home sometimes for short occasions on business, it may

be for lectures, or for public functions that cannot properly be missed, and in a couple of months the Irish Lights cruise must be made. I don't mean to say that these trips are *only* business, for I enjoy them greatly, but, nevertheless, they are business and have to be attended to, as grievous loss would otherwise ensue.

"I shorten these necessary absences by every hour I can, but the conclusion to which these remarks tends is that I must sternly refuse any such attractions as those of the trip to Cruden Bay.

"My dear and valued friend, I have told you exactly how the matter stands, and you won't be angry with me. I shall be free all next term for a round at Royston whenever you will do me the honour."

The last golfing friend to whom I would refer is Mr. J. D. Duff, Fellow of Trinity College. He was a member of the Royston Club, and as a resident in Cambridge, who lived not far from the Observatory, he was nearly always available. My father used to enjoy greatly his games with Mr. Duff. Of him he wrote to a friend (August 26th, 1903):

"Duff, my golfing companion, is dividing his summer between golf and learning Russian! He does not know which is the most amusing, and certainly pronounces Russian the better exercise!"

Mr. Duff has very kindly written an account of his relations with my father. I gladly insert it in these pages for a special reason: he has been able to express his opinion with a freedom not permitted to one who is nearly related to the subject of this memoir:

"Sir Robert Ball's life included many activities in which I had no share. Of the sciences, in which his reputation was made, I knew nothing; nor did I ever do business with him, or sit on any board of which he was a member. Yet for more than ten years I had the happiness to enjoy very intimate relations with him. This came about because we were in the habit of playing a game which brought us together for five or six hours at a time, and alone together, except that we each had a small boy walking at our heels and carrying the implements of our game. The game was golf; and the place where we played was Royston Heath.

"It was at Royston that I first saw Sir Robert and first made his acquaintance—about the year 1900. Soon afterwards it became a settled thing that we should play there once a week, generally on Saturday, during term time and Long Vacation, if engagements allowed and the weather were at all tolerable.

"It takes a long time to play golf at Royston from Cambridge. There is a train journey of thirteen miles, and the trains do not fit. Then a considerable distance divides the Observatory from the station at Cambridge, and a shorter distance Royston Station from the Heath. And, after all this, there is an exasperating walk between the club-house and the first tee. Yet, if you had Sir Robert for your companion, you did not find all these stages and delays tedious, nor yet the interval that followed between tea and the returning train. His custom was to drive from the Observatory, and call for me either at my house or in College. Arrived at Royston, we drove to the Heath in a bus, had a mouthful of lunch, and started for the first tee. He never went to Royston in his golfing clothes, but changed there before and after playing. It was a marked trait in his character that he disliked anything slovenly or slipshod in the way of dress; he would have agreed heartily with Scott's objection to 'bedgown and slipper tricks' for able-bodied men. Yet he was not at all critical of other people who might be less particular as to their travelling garb. In playing, he wore flannel clothes, dark jacket and light trousers, dark cloth cap, and tennis shoes with stout soles. He did not smoke himself, and in returning from Royston he generally avoided the smoking carriages, which were apt then (for things have improved since, and third-class smokers have learned better habits) to be somewhat unattractive after plying all day between Cambridge and London.

"The heath at Royston was not intended by Nature for golf; the soil is chalk and the hazards are artificial. One of these hazards is, or was, a plantation of whin bushes on the way to the thirteenth hole. When Sir Robert first saw this obstacle he laughed and said to me: 'If whins would grow here at all, the whole heath would be covered with them.' Time proved him to be right: the whins never did well, and now offer no impediment to the feeblest golfer. Yet, in spite of natural defects, the care of the green committee and the feet of many golfers have done wonders. Apart from golf, the heath is a delightful place, with fine, fresh air blowing over it, and wide views of a great surrounding plain of cornfields and distant woods. Many parts of it are covered with all the flowers that grow on chalk, from the pulsatilla and cowslips of spring to the spiræa and blue scabious of late

summer; milkwort, blue and red, grows all over it, and there are many kinds of orchis. Natural knowledge of all kinds came easy to Sir Robert, and I learnt from him the names of many of these plants. I think we both felt prouder of our pretty pulsatilla when he had looked it out in his Bentham and found that it was 'rare.' There it is far from rare: parts of the heath are blue with it about Easter time.

"He took pains with his game, and improved steadily for some years. He was one of those golfers to whom the introduction of the rubber-cored ball made a real difference in the success and pleasure of their game. The first of these balls was the Haskell; and there was also an inferior variety called, I think, the Kemshall, of which I had procured some specimens. He was rather unwilling to abandon the old 'gutty,' which he had always used; but I did induce him one day to play with a Kemshall, and his conversion was instantaneous and complete. He carried few wooden clubs, but a fair number of irons, with which he often did useful work when approaching the hole; and he was a careful and steady putter. Before long he was able to complete the round in considerably less than a hundred strokes. But he played golf in the right spirit—the spirit which would have satisfied even that remarkable purist of golf, the late Mr. George Glennie: the card and pencil were never to his liking; he cared little for his score and much for his match. We never took cards from the club-house; we paid no heed to monthly medals or bogey competitions; but we each worked hard to defeat the other, and spent many happy hours in that endeavour.

"Ball was an excellent partner, and entirely free from those faults which mar some of the best of men when they have a golf-club in their hands. He was incapable of arriving at the hole-side and there stating that he was totally unaware whether he had played five or six. When his antagonist played the most infamous strokes, he never expressed either surprise or pity; when a putt of six inches was missed, he never laughed. Yet good men have done such things. His native tact told him that a stony silence is the only true politeness on these melancholy occasions. He realised, too, that the game had an ancient and honourable history, and he treated it with respect: he would never have proposed to a partner to ignore stymies, or to omit the bye and walk home, when the match was over!

If he had a fault as a golfer, it was that he moved rather slowly up the steep Royston hills. But he was always most willing to let others pass; and, if the couples behind him were sometimes kept back, he was such a general favourite that to be kept back by him was no grievance.

"On the way to Royston, and still more on the course, we talked constantly on all kinds of subjects. There were few things we did not talk about except the 'shop' of our respective studies; and that abstinence probably did something to make Royston a more complete change. Yet I heard much from him of contemporary men of science, all of whom he knew, and whom he was in the habit of meeting at the Royal Society and elsewhere. I once said to him that I was one of the few persons in England who had never heard him lecture. At the time he said nothing; but the next time that he gave a popular lecture in Cambridge—I believe it was for the benefit of the Y.M.C.A.—he sent me tickets, and I heard him lecture on 'Nebulæ,' and saw at once how well he deserved his reputation as a lecturer.

"But our talk ordinarily turned on more general subjects. He had seen much of life, and seen it with an observant eye; and his remarks—whether on the ways of men and women he had known, or on the causes of success and failure in life, or on marriage and the training of children—were always worth hearing. It seemed to me that, beyond most men, he understood the rules of a game more complicated than golf—the game of life—and that he practised them with success. Yet no man was more actively kind to those who had proved less able to master the rules and had lost most of the holes in life's round to victorious fortune. He had, with an Irishman's face, an Irishman's love of fun, and his sense of humour was one of the most obvious things about him. But one always felt that behind this there was no common degree of practical sense and of that shrewdness which is sometimes supposed to be monopolised by another part of Great Britain. I suppose that he had his share of troubles and worries, but he kept those to himself. His good spirits were unfailing. He was always an easy and copious talker. At times he told stories; yet he never fell into the pitfall digged for the feet of most men who tell them. From him I never heard a story which I knew already, or a story which failed to amuse. Many of his best stories

were dry sayings of Americans. He knew that country and had a marked liking for its people. He admired their achievements in astronomy; and he admired also their mastery over the minor arts of practical life. Thus I remember his praising the skill of American barbers as far beyond the European standard; I believe he said that, after one of these artists had shaved you, it was superfluous labour to shave the next day!

"I have said that Sir Robert Ball was a general favourite. It was one of the first things that you noticed when you went about with him. Everyone knew him, and everyone liked him. It was curious to watch the railway guards and porters, the club servants and the caddies: every face brightened at his greeting. On the heath it was the same: if we came within hail of a couple, one of the two was sure to recognise him and speak. A superficial observer might have supposed that a man so universally popular dealt only in pennyworths of friendship, so that everyone got some from him and no one got much. But such a supposition would have been utterly wrong. Just as he seemed to combine the light heart of the Irishman with the long head of the Scotchman, so his pleasantness to all the world did not exclude the power of deep and strong attachment to particular persons. If you were his friend, he had, more than any other man I have known, the power to make you feel, without any demonstrativeness on his part, that your friendship was pleasant to him. He had, what is rarer than is generally supposed, a keen sense of his friend's joys or sorrows. Nor was his friendship limited to yourself. If he visited a place where your boys were at school, he hunted them out and tipped them; your mother and sisters were people whom he wished to know and took trouble to see. How many friends can any man count who will do all this as a matter of course?

"We played our last round of golf together on Monday, January 15th, 1912. The day before he had taken my children round the Observatory and shown them the great telescopes. At Royston he seemed in his usual health; but he walked very slowly —so slowly that we had to omit several holes in order to catch our train. That was the end of one of life's pleasant things.

"This is a bright day in April, and on Royston Heath the pulsatilla is even now opening its purple flowers to the sun. But there are some for whom neither place nor flower can ever have quite the same charm again."

CHAPTER XVIII

SIR ROBERT AND POLITICS

BEFORE he left Ireland my father took no very active interest in politics. He was known to be a Unionist, but it is probably true to say that his scientific attainments had earned the respect and admiration of every Irishman, whether Unionist or Nationalist, Protestant or Roman Catholic. When the second Home Rule Bill was under discussion he chanced to be at an entertainment in Dublin where many eminent men were gathered together. A cleric who had attained high preferment in the Roman Catholic Church was at pains to assure the Astronomer Royal that, whatever changes might be made in Ireland when Home Rule was achieved, men of his standing would not be interfered with. "I am glad to hear it," was the reply. "As the name of Sackville Street has recently been changed to O'Connell Street, I had grave apprehension lest a Nationalist government might begin to tamper with the constellations. I feared I should live to see the day when I should 'look on great *O'Brien* sloping slowly to the West!'" *

He went to a political meeting for the first time on February 15th, 1893. Writing from Cambridge to Mrs. Millington, he said:

"This evening I went for the first time in my life to a political meeting to hear Mr. Blake, formerly Prime Minister of Canada, and now an Irish Nationalist member. There is an extraordinary difference between the smooth way in which they present Home Rule over here and the actual reality as we know it. But Gladstone has very few supporters here, notwithstanding that his daughter as head of one of the Newnham halls is a notability of the place."

He had something to say about Old Age Pensions and the Coal Tax which was imposed during the Boer War in a letter dated April 23rd, 1901:

* See "Locksley Hall," v. 4.

"I read with much interest about the Old Age Pensions. The cost of this awful war would have provided *for ever* 400,000 pensions of 5s. a week. Is not the wrath of the coal owners splendid? The men who have been fleecing us to the tune of 10s. or 15s. of a rise in coal last year are now whining that a rise of 1s. will paralyse trade and ruin the country. I hope for once Hicks Beach will sit tight. If he does not I will become a Home Ruler. He ought to have made the tax half-a-crown. I saw somewhere lately a calculation showing that the *abnormal* profits pouched by those coal owners in last season exceeded £20,000,000."

In 1902 it was rumoured that Mr. Lecky, who with Sir Edward Carson represented Trinity College, Dublin, in Parliament, was about to be raised to the Peerage. The question having been mooted as to who should succeed him, it was suggested that Sir Robert Ball should come forward.

He decided *not* to become a candidate. Dr. Salmon, who wrote approving his decision, expressed some interesting views on University representation:

"I consider you have been wisely advised in deciding not to allow your name to be put forward. If you had remained at Dunsink I should not have approved of your being absent. Lecky has made a first-rate figure-head for us, and you, too, would have been a creditable one; but as things are we are not likely to secure anyone whose name is known outside our island. The claim for Universities to representation has of late years been strongly criticised, but it has been a good practical answer that the three constituencies send such representatives as Foster, Jebb, and Lecky. On these grounds I think the University authorities are well justified in not being severe in their requirements from eminent professors. Macaulay notes with pleasure that Cambridge was represented by Sir Isaac Newton in a deputation to James II. If the Cambridge authorities could have strained a point in your case, all Universities would have been the better for its lead. I admit that in your case a good deal of straining would be necessary."

In 1904 he was Chairman of the Cambridge University Representation Committee. Sir Richard Jebb having been chosen as candidate to represent the University in Parliament, he wrote to Sir Robert (January 22nd):

"I am grateful to the meeting over which you have presided for their decision to support my candidature in conjunction with that of Mr. Rawlinson."

The committee supporting Sir R. Jebb included the Rt. Hon. Austen Chamberlain, M.P., and the Rt. Hon. Alfred Lyttelton, M.P.

Apart from University politics my father did on one or two occasions—notably during the General Election of 1906—enter the wider political arena. He addressed public meetings in support of Mr. Almeric Paget, who was candidate for the town of Cambridge. But the atmosphere of political meetings was uncongenial to him. In his element on the lecture platform, he was out of it when attempting to convince the sturdy and independent elector. At one meeting he was much disconcerted by an interruption from the back of the hall: "I say, Professor, you've got your eye to the wrong end of the telescope!"

In December, 1905, Mr. S. H. Butcher was chosen to stand for the University of Cambridge. He wrote to Sir Robert (December 17th):

"Let me thank you for your telegram, so promptly sent, containing the decision of the meeting. To receive so unanimous an invitation is a signal honour; no one could feel it more than I do. Yesterday evening I could merely wire in a word or two the fact of acceptance; but may I now add to that a request that you will express to your Committee and, if possible, to a larger body of my supporters my profound and grateful appreciation of the honour."

At the Election in January, 1906, which resulted in the return of Mr. S. H. Butcher and Mr. J. F. P. Rawlinson, K.C., as members for the University, Sir John Gorst was the opposing candidate. Mr. Rawlinson has been good enough to record his impression of Sir Robert as Chairman of the Representation Committee at a time when Cambridge politics were in a somewhat troubled state. He wrote as follows:

"Your father carried out the work preliminary to and connected with the contest with extraordinary tact. As Chairman of the Committee he was as a rock against which the waves of controversy beat in vain. His energy, too, was amazing. One had only to write to him, and a thing was *done*. He accepted responsibility with the greatest readiness, and I formed the impression that I was dealing with a really great man. What struck me most about him was his marvellous power of dealing with men—whether friends or foes. Indeed, I think he was almost a genius in this respect; and while he fought on our behalf a strenuous fight, he made no enemies from first to last."

Sir Robert and Politics

That Sir John Gorst carried away none but pleasant recollections of the contest appears from a letter which my mother received shortly after my father's death:

"84 CAMPDEN HILL COURT,
"LONDON, W.
"*November 26th*, 1913.

"DEAR LADY BALL,

"I cannot help, in recollection of our old days of friendship at Cambridge, writing a line to express to you my sorrow at the death of my old friend Sir Robert, and my sincere sympathy with all your family, who are bound together by ties of the deepest affection. We spent many happy times together in the past; and though I have been for some years parted from Cambridge, I still retain a fond memory for the friends I was so intimate with there. I hope that with the healing influence of time the bitterness of the sorrow you must all feel will be assuaged, and that the recollection of your dear husband will be a sweet memory for your life.

"Believe me,
"Yours faithfully,
"JOHN E. GORST."

In 1911 my father was invited to become a candidate to represent the University of Cambridge in Parliament in succession to Mr. S. H. Butcher. He refused to allow his name to be put forward, but he consented to act as chairman of committee for Sir Joseph Larmor, who was subsequently elected. His reasons for declining to enter Parliament are given in a letter to a friend:

"I have been asked, nay, pressed, to stand for the University, and have been assured in most influential quarters that there would be no opposition. But it is impossible. Such a career should not be commenced by a man over seventy. I have found it hard to make some of my friends admit this point, but I have not entertained the notion for a moment. Controversy with Nationalist members is not my line in any case.

"But I do not mind telling you that I have been greatly touched by the kindness and confidence that is shown to me by all these friends. People whom I would never have expected to do so stop me in the street or ring me up on the telephone with the same story, and no one more urgently than our excellent Rawlinson, M.P. They credit me with all sorts of virtues that I don't possess, and especially common sense. They say that now I have given up my lectures and the University Council I would have plenty of time, etc., etc.

"The humour of the situation is that troops of the most nondescript and unknown politicians are writing to offer themselves! I have had three letters to-day from men I have never heard of before, and who speak as if I had the gift in my pocket."

Sir Joseph Larmor having been chosen as candidate, Sir Robert threw himself with all his energy into the contest. Writing again on January 26th, he said:

"Ordinary politics ought to have no place in a University election. If we are merely to send the type of man that would do for Eatanswill or Little Diddlington, the sooner the University is disfranchised the better. Every day I thank my stars that I am in it, not as a principal, but only as Larmor's chairman. In that capacity I have ten Heads of Houses and innumerable Professors already under my baton. We have a strenuous lot of most capable people working, and it is really great fun."

After it was over he wrote again to the same friend (March 10th):

"We had a keen fight at the election. The other side really worked their canvass much better than we did, and they had a fortnight's start. I think they wrote personal letters to all the electors as well, otherwise we should have had a much bigger majority. Ridgeway's letters in the *Times* were most effective.

"If they begin to pay the members there will be an element of bitterness in elections which is now wanting. I see by the papers that there are already scores of actions for libel arising out of the last elections. Will not these be multiplied and intensified if it can be urged that the libels not only attributed views to a candidate which he abhorred, but also robbed him of £400 a year? Juries will take account of this, even though judges may tell them they should not do so.

"Mr. Harold Cox was, in his undergraduate days, by way of being a 'Positivist' (whatever that may mean). Someone wrote to say that the professors of that faith in Cambridge were much divided *inter se*. Cox replied that this was a calumny. The 'Positivist' body in Cambridge were entirely united. This he knew, because he and his brother formed the entire party and they were in absolute agreement!

"We chaffed the supporters of Cox by pointing out our good feeling in abstaining from bringing Cox's Positivist proclivities before the notice of the electorate. They quite acknowledged this, and said that in consequence of our courtesy they abstained from comment on the fact that Larmor was an Ulster Presbyterian!

Sir Robert and Politics

"I am retiring from active participation in political matters here. The wonder to me is how I ever got involved in them. I have just four more lectures to give, the first on Wednesday next at Plymouth; the last at Eastbourne on April 1st (save the mark!). I have a fine collection of invitations to lecture which I had to refuse. But they have now ceased to come."

Although he retired from active politics after Sir Joseph Larmor's election, his interest in matters political remained unabated.

On October 18th, 1911, he wrote to a friend:

"It seems that the Eighty Club went to Arran. It included, I blush to say, some Cambridge men. They report here that the Isles of Arran have given up fishing or kelp burning. I suppose the peasants have discovered a more lucrative industry and one that is no trouble, namely, Old Age Pensions. Sixty pounds a week is doled out there in pensions, as it appears that owing to the peculiarities of the climate even young men are over seventy years old!

"You or I might see in this new industry merely one more illustration of the way in which the Old Age Pension scheme can be abused. I wonder how many Arran Islanders would want Home Rule, accompanied by the condition that they were to look in future to an Irish Parliament for the two weekly half-crowns!

"I have in front of me 125 applications for the post of gardener here, nearly all of them the result of a single advertisement in the *Morning Post*.

"They offer to grow me pineapples, fresh green peas for Christmas, and ripe strawberries every day of the year! I sternly say: 'Can you see weeds, and will you pull them up?'"

CHAPTER XIX

THE END

TOWARDS the close of his life my father was troubled with the symptoms of a malady which in a younger man would have soon proved fatal. A strong constitution, however, carried him through for a considerable time, but for two years he was unable to do any active work. He was wholly confined to bed for the last six months.

In sickness, as in health, he was always thoughtful for others. One of his kind nurses told me that he was a patient who never forgot that the nurse sometimes gets tired.

But all that gentle hands and skilled nursing could do failed to keep him longer with us, and he passed peacefully away on November 25th, 1913, having borne a long and trying illness with characteristic patience. Suspended above his deathbed was an almanac in which the favourite mottoes of various eminent men were entered on each day of the year. The motto, which he himself had chosen, for November 30th was a passage from Carlyle—a passage which, in going through his papers, I have since found noted by him so long ago as 1879:

"Happy is the man who has found his work! Let him ask no other blessedness. He has a work, a life purpose; he has found it and will follow it."

The funeral service was held in King's College Chapel on November 29th, in the presence of a large congregation, which included representatives of seats of learning and scientific societies from all over the country. During the service his favourite hymn, "Rock of Ages," was sung by the choir to which he had listened so often on Sunday mornings. He was carried from the chapel through the great west door, and was laid to rest in St. Giles's Cemetery, on the Huntingdon Road, at Cambridge, not far from the spot where his predecessor, the discoverer of Neptune, was buried twenty-two years before.

The End

When the last rites were performed his grave was lit up for a few moments by the sun he loved so well.

I conclude this memoir with one of a great number of letters which my mother received after his death :

"TRINITY LODGE,
"CAMBRIDGE.
"*November 25th*, 1913.

"MY DEAR FRIEND,

"So all the long struggle is now over, and even your loving unwearied care can do no more. How much love he carries away with him! Ever since he came to us from Ireland he has been sowing and reaping affection on all sides—so kind, so cheery, so beautifully sympathetic. I cannot dwell upon our *public* loss. When shall we ever again have a lecturer whose science and wit and playfulness combined can absolutely rivet any audience from a savant to a little child?

"But I am thinking now of the charm of his goodness and kindness, and what the silence must now mean to those whom he loved best in his happy home.

"I can say with truth that no day has passed for many weeks without my thinking of his invalid bed, and of her who watched him so tenderly. You will have your reward in every remembrance of him in the years to come on earth, and, as I believe, in the infinite years that come after.

"With love from us both,
"Believe me, affectionately yours,
"H. MONTAGU BUTLER"

APPENDIX

A *CATALOGUE RAISONNÉ* OF SIR ROBERT BALL'S MATHEMATICAL PAPERS

BY

E. T. WHITTAKER

[When sending me the following *catalogue raisonné* of my father's books and mathematical papers, Professor Whittaker wrote:

"Here is my attempt to sketch the development of Sir Robert's mathematical researches. . . . You must use your judgment as to whether it is suitable for publication in the 'Reminiscences.' On my part it is simply a slight tribute of affection to one whom I loved more than any other of my teachers."

The reader who refers to p. 152, *ante*, will find that the esteem and affection of pupil for teacher was warmly reciprocated.]

It is interesting to trace the steps by which Ball was led to the mathematical discoveries which are associated with his name; especially as his earliest papers gave no indication of the direction in which his energies were ultimately to be concentrated.

The first of them, written in 1865, when he was a candidate for Fellowship in Trinity, is purely algebraical,* and is of interest chiefly as showing that he already possessed that unifying and co-ordinating power which made him in later life the prince of expositors. Taking in succession the methods of solving biquadratic equations which had been given by Ferrari, Simpson, Euler, Descartes, Lagrange, and Cayley, he shows their substantial identity: each of them depends essentially on the same reducing cubic. This subject was carried farther in a second paper,† in which the methods of Tchirnhausen and others were examined; but his election in 1867 to the Chair of Applied Mathematics and Mechanics in the Royal College of Science at Dublin gave a new turn to his thoughts, and his next papers were on wholly different topics.

The first of them,‡ a slight and isolated note on a phenomenon of the nature of a mirage which he observed from the deck of a

* "Note on the Algebraic Solution of Biquadratic Equations," *Quart. Journ. Math.* 7 (1866), pp. 6-9.

† "Notes on Biquadratic Equations (Second Part)," *Quart. Journ. Math.* 7 (1866), pp. 358-69.

‡ "On an Optical Phenomenon (Mirage)," *Phil. Mag.* 35 (1868), p. 404.

steamboat, is of interest chiefly as reflecting his keen power of observation and love of applying scientific principles to the happenings around him. It was followed by a paper* of a purely experimental character on vortex-rings. A year previously, W. Thomson (Lord Kelvin) had suggested that the atoms of matter might be constituted of vortex-rings in a perfect fluid, and that the mutual interactions of atoms might be illustrated by the behaviour of smoke-rings. Ball now described some beautiful experiments on the passage of a smoke-ring through a column of smoke. The subject was pursued in later papers†; but it was not as an experimental physicist that he was destined to achieve his real reputation.

The teaching work of his Chair led him to devise many new lecture-experiments and examinations of mechanical efficiency, which formed the subject of communications in 1869 and 1870‡; and to this period belongs also his earliest paper on an astronomical subject.§ But the needs of his class led him also to work in the theoretical science of dynamics, and it was here that he found a thoroughly congenial topic and developed the ideas on which his greatest work was afterwards constructed.

His first contribution to theoretical dynamics was a new proof‖ of Lagrange's formula connecting the tension and curvature of a membrane subjected to fluid pressure; his second,¶ written in April, 1869, which may be regarded as the germ of his principal series of researches, was a discussion of the small oscillations of a particle on any surface acted upon by any forces. In a paper written many years afterwards** Ball gave an account of the way in which he was led to this investigation. In the spring of 1869 he happened to attend a lecture at the Royal Dublin Society, given by Dr. Johnstone Stoney, in the course of which the lecturer exhibited and explained the progression of the apse in the elliptic path of the bob of a conical pendulum. Interested in the exposition, Ball began immediately to work at the mathematical theory of the subject, in the endeavour to understand it more fully: and in this way he arrived at the results embodied in his *Quarterly Journal* memoir.

This was followed by a communication made to the British Association at its Liverpool meeting in 1870,†† in which the work

* "On Vortex-rings in Air," *Phil. Mag.* 36 (1868), p. 12.

† "Account of Experiments upon the Resistance of Air to the Motion of Vortex-rings," *B.A. Rep.* 41 (1871), pp. 26-9; *Phil. Mag.* 42 (1871), p. 208. "Account of Experiments upon the Retardation Experienced by Vortex-rings of Air when Moving through Air," *Irish Acad. Trans.* 25 (1872), pp. 135, 155; *Irish Acad. Proc.* I. (1873-4), p. 113.

‡ "Lecture-experiments to Illustrate the Laws of Motion," *Phil. Mag.* 37 (1869), pp. 332-9. "Account of Experiments upon the Mechanical Efficiency of Different Forms of Pulley-blocks," *Dub. Soc. Journ.* 6 (1870), pp. 70-5.

§ "On Nebulæ," *Dub. Soc. Journ.* 5 (1870), p. 339.

‖ "Note on an Elementary Proof of a Theorem of Lagrange's," *Phil. Mag.* 39 (1870), pp. 107-8.

¶ "A Problem in Mechanics," *Quart. Journ. Math.* 10 (1870), pp. 220-8.

** *Trans. R.I.A.* 31 (1897), p. 185.

†† "The Small Oscillations of a Particle and of a Rigid Body," *B.A. Rep.* 40 (1870), pp. 10-12; *Quart. Journ. Math.* 11 (1871), pp. 206-9.

was extended so as to include the small oscillations of rigid bodies, and in which the characteristic features of his theory begin to appear.

There can be little doubt that this theory was originally suggested to his mind by considering the problem of small oscillations in the light of the kinematical theories of the French geometers. Louis Poinsot (1777-1859), Augustin Louis Cauchy (1789-1857), and Michel Chasles (1793-1880) had shown* how the various possible displacements and motions of rigid bodies can be analysed mathematically into certain elementary types. The most important of these types is the "screw-displacement," which is simply the motion of a nut upon an ordinary screw; the nut moves forward and at the same time turns round, the amount of the forward motion bearing a definite proportion to the amount of rotation. Poinsot had proved that a rigid body can be transferred from one position in space to any other position in space by a "twist" about a certain screw; and that any system of forces acting upon a rigid body can be compounded into a "wrench" about a certain screw.

In the British Association communication of 1870, Ball extended this circle of ideas so as to obtain a complete theory of the small oscillations of a rigid body in terms of the screws. It was shown that the movement of a free rigid body when making small oscillations is compounded of six normal movements, each consisting of a to-and-fro vibration about a *normal screw*, the position, pitch, and period of which depends upon the forces; and that if a rigid body have k degrees of freedom, its motion is compounded of vibrations about k normal screws.

In the Theory of Screws which was now taking shape in his hands, Ball regarded a screw as consisting simply of a straight line (the axis of the screw) with which a parameter (the pitch of the screw) is associated. This constitutes a common basis for the study of twists, which are kinematical displacements, and of wrenches, which are systems of mechanical forces. Now with every screw so defined we can associate a certain linear complex of lines,† namely, the null lines‡ of the wrenches belonging to the screw; and, conversely, Ball's screw is completely defined by this linear complex. It will be evident from this that the Theory of Screws is closely connected with the Theory of Linear Complexes in Line-Geometry§; and, as a matter of history, many of the theorems discovered by Ball were discovered independently by workers in the field of line-geometry. As an instance of this we may mention the theory of reciprocal screws. Ball termed two screws "reciprocal" when a wrench acting on either does no work as the body is twisted about

* The matter had been discussed still earlier in a little-known work of G. Mozzi, published at Naples in 1763.

† That is to say, a triply-infinite set of lines in space, between whose line co-ordinates a linear relation exists.

‡ That is to say, the lines about which the moment of the system is zero.

§ The conception of a geometry in which the element of space is taken to be the line instead of the point is due to Plücker; it had been suggested by him as far back as 1846, but its chief development dates only from the publication of his "Neue Geometrie des Raumes" in 1868-9.

the other, and established many properties of reciprocal screws—e.g. that a screw can be determined so as to be reciprocal to five given screws. Klein, working about the same time* at the theory of linear complexes, defined complexes "in involution" by a condition which is really equivalent to Ball's condition of reciprocity, and obtained results regarding six "complexes reciprocally in involution" which are precisely the same as his.

At the period of these earlier investigations Ball was not aware of the work of the line-geometers. He first heard of them from Professor Felix Klein at the Bradford meeting of the British Association in 1873.

At the British Association meeting of the following year (1871), which was held at Edinburgh, Ball described the cubic surface, of fundamental importance in the theory of screws, to which, at Cayley's suggestion, he gave the name *cylindroid.*† The composition of two displacements of a rigid body about two given screws gives a resultant which could have been produced by displacement about a single screw: the locus of this single screw is the cylindroid. Its fundamental property is that, if any three screws of the surface be taken, and if a body be displaced by being screwed along each of the screws through a small angle proportional to the sine of the angle between the remaining screws, the body, after its last displacement, will occupy the same position that it did before the first.‡

The theorem of the cylindroid includes as particular cases the well-known rules for the composition of two displacements parallel to given lines, or of two small rotations about intersecting axes.

From this time commences his long series of communications to the Royal Irish Academy on the theory of screws and related problems,§ and a number of memoirs on the same subject in various English and Continental journals.‖ The first of his twelve principal

* Klein's paper was published a few months before Ball's. Cf. *Math. Ann.* 2, pp. 204, 368.

† "Exhibition and Description of a Model of a Conoidal Cubic Surface called the 'Cylindroid,' which is presented in the theory of the Geometrical Freedom of a Rigid Body," *Brit. Ass. Rep.* 41 (1871), pp. 8-9; *Phil. Mag.* 42 (1871), pp. 181-3.

‡ The cylindroid, like the reciprocal screws, had been anticipated in some degree by the line-geometers. Cf. Plücker's "Neue Geometrie des Raumes" (1868-9), p. 97; see also Battaglini, *Napoli Rend.* 8 (1869), p. 87.

§ The earliest was "On the Small Oscillations of a Rigid Body about a Fixed Point under the Action of any Forces, and more particularly when Gravity is the only Force Acting," *Irish Acad. Trans.* 24 (1871), pp. 593-628; *Irish Acad. Proc.* I. (1873), pp. 11-13.

‖ "On a Geometrical Solution of the following Problem: 'A Quiescent Rigid Body Possessing Three Degrees of Freedom Receives an Impulse, Determine the Instantaneous Screw about which the Body Commences to Twist,'" *Brit. Ass. Rep.* 43 (1873), pp. 26-7. "Contributions to the Theory of Screws," *Brit. Ass. Rep.* 43 (1873), pp. 27-8. "On a Screw-complex of the Second Order," *ibid.* 45 (1875), p. 10. "The Theory of Screws: A Study in the Dynamics of a Rigid Body," *Math. Ann.* 9 (1876), pp. 541-53. "On the Principal Screws of Inertia of a Free or Constrained Rigid Body," *Phil. Mag.* 6 (1878), p. 274-80.

memoirs was published in the Irish Academy's *Transactions* in 1872,* and consisted chiefly in a systematic recount of the discoveries which had been presented in a fragmentary way in the shorter papers. The second of the twelve great memoirs appeared† in the *Philosophical Transactions* of 1874: the chief feature of this paper is the general theorem that a rigid body has just as many principal screws of inertia as it has degrees of freedom. This is a generalisation of the well-known property of the principal axes of a rigid body rotating around a fixed point. The third memoir of the series appeared in 1875‡; in this he introduced *screw co-ordinates*, which play a considerable part in the theory. They may be described as an adaptation for dynamical purposes of Klein's co-ordinates of a linear complex referred to six fundamental complexes, of which each pair are in involution.

The results of the first three memoirs were incorporated in a volume which Ball published in 1876 under the title, "The Theory of Screws: A Study in the Dynamics of a Rigid Body."§

In the midst of these investigations he continued his work in applied mechanics, publishing his well-known books‖ on the subject in 1871 and 1873, and two original papers¶ on it in the latter year, while in 1872 we find two papers on an astronomical subject.** Astronomy was, indeed, to claim much of his life henceforward, for in 1874 he exchanged the Professorship of Mechanics in the Royal College of Science for the office of Royal Astronomer of Ireland. The dignity of this position, enhanced by his election to the Royal Society in the previous year, gave him, at the early age of thirty-four, a leading position among Irish men of science. That his merits as a lecturer were already recognised appears from the published abstract, of date 1871,†† of a discourse to the Royal Dublin Society.

Ball's devotion to his new profession was soon made evident by

* "The Theory of Screws: A Geometrical Study of the Kinematics, Equilibrium, and Small Oscillations of a Rigid Body," *Irish Acad. Trans.* 25 (1872), pp. 157-215; abstract in *Quart. Journ. Math.* 12 (1873), pp. 41-7, and *Irish Acad. Proc.* I. (1873-4), pp. 233-8.

† "Researches in the Dynamics of a Rigid Body by the Aid of the Theory of Screws," *Roy. Soc. Proc.* 21 (1873), pp. 385-6; *Phil. Trans.* 164 (1874), pp. 15-40.

‡ "Screw Co-ordinates and their Application to Problems in the Dynamics of a Rigid Body," *Irish Acad. Proc.* I. (1873-4), pp. 552-3; *Irish Acad. Trans.* 25 (1875), pp. 295-327.

§ Dublin; Hodges, 194 pp.

‖ "Experimental Mechanics," 352 pp. (1871). "Elementary Lessons on Applied Mechanics," 143 pp. (1873).

¶ "Notes on Applied Mechanics: 1.—Parallel Motion. 2.—The Contact of Curves." *Irish Acad. Proc.* I. (1873-4), pp. 243-5; *Quart Journ. Math.* 12 (1873), pp. 112-4. "Notes on Applied Mechanics: 3.—Of the Theory of Long Pillars. 4.—Note on a Hydrodynamical Theorem Due to Prof. Stokes." *Irish Acad. Proc.* I. (1873-4), pp. 491-3.

** "On the Orbit of the Binary Star ξ Ursæ Majoris," *Monthly Notices R. A. S.* 32 (1872), pp. 336-9. "On a New Approximation to the Orbit of the Binary Star ξ Ursæ Majoris," *Irish Acad. Proc.* I. (1873-4), pp. 316-28.

†† "On Energy," *Dublin Soc. Journ.* 6 (1875), pp. 187-9.

a profusion of books* and original papers.† But his interest in the screws in no way abated, and, indeed, developed in several new directions. In 1880 he communicated‡ to the British Association an extension of the theory to the kinematics of a rigid body in non-Euclidian space. The most general displacement of a rigid body is a rotation about an axis combined with a rotation about the polar axis with regard to the absolute: Ball found geometrically the joint effect of two small displacements. At the meeting of the following year he showed§ that the properties of a system of surfaces arising in the theory of screws are only the "survivals" of a more interesting geometrical system in non-Euclidian space. The result was to give a complete geometrical theory of the statics and kinematics of a rigid body with three degrees of freedom in non-Euclidian space. The non-Euclidian researches were presented in detail in the fifth of his great series of memoirs,‖ with which may be associated another paper¶ of somewhat later date. The fourth memoir** of the series, which had been read to the Royal Irish Academy somewhat earlier in the year, contained an extension of the theory of screws (which had hitherto been occupied with the dynamics of *one* rigid body) to the case of *any connected system* of rigid bodies. In this memoir Ball introduced the notion of *screw-chains*, which bear to such systems the same relation that a screw bears to a single rigid body. By means of this conception he obtained for general systems

* "Astronomy," 166 pp. (1877). "Elements of Astronomy," 459 pp. (1880). "The Story of the Heavens," 530 pp. (1886). "Time and Tide" (1889). In this period he also wrote the article "Gravitation" for the Encyclopædia Britannica," and his "Mechanics," 167 pp. (1877), which was translated into Italian, and published *sub tit.* "Mechanica," Ball-Benetti (Ulrico Hoepli; Milano) (1880).

† "Observations of the Minor Planets (9) (13) (75) (97) (111) with the Transit-circle at Dublin," *Monthly Notices* 37 (1877), pp. 14-5; "On the Annual Parallax of the Star P. III. 242," *Monthly Notices* 41 (1881), pp. 36-42. "Further Researches on the Annual Parallax of 61 Cygni," *Monthly Notices* 41 (1881), pp. 162-6. "On a Simple Approximate Method of Calculating the Effect of Refraction upon the Distance and Position-angle of two Adjacent Stars," *ibid.* pp. 445-7. "Researches on the Annual Parallax of the Star Groombridge 1618," *Copernicus* 1 (1881), pp. 16-22. "Determination of the Annual Parallax of 6 Cygni $\beta = \Sigma$ 2486," *Copernicus* 2 (1882), pp. 159-63. "On the Method of Regulating a Clock Intended to Show Correct Mean Time," *Irish Acad. Proc.* 3 (1883), pp. 66-8. "Researches on the Parallax of 61 (A) Cygni made at Dunsink," *ibid.* pp. 209-12. "Observations in Search of Stars with a Large Annual Parallax," *ibid.* pp. 215-26. "Speculations on the Source of Meteorites," *ibid.* pp. 227-30. "Researches on Annual Parallax made at Dunsink," *ibid.* pp. 355-67; and the "Dunsink Observations and Researches," published separately.

‡ "Notes on Non-Euclidian Geometry," *B. A. Rep.* (1880), pp. 476-7.

§ "On the Elucidation of a Question in Kinematics by the Aid of Non Euclidian Space," *B. A. Rep.* (1881), pp. 535-6.

‖ "Certain Problems in the Dynamics of a Rigid System Moving in Elliptic Space," *Irish Acad. Trans.* 28 (1881), pp. 159-84.

¶ "On the Theory of the Content," *Trans. R. I. A.* 29 (1889), pp. 123-82.

** "Extension of the Theory of Screws to the Dynamics of any Material System," *Irish Acad. Trans.*, 28 (1881), pp. 99-136. Cf. *B. A. Rep.* (1881), pp. 547-8.

a theory similar to that of the principal screws of inertia of a single rigid body.

Three papers on Lagrange's equations in dynamics and their application to the theory of screws appeared * before the fifth memoir, and between the fifth and sixth memoirs Ball published a number of shorter papers dealing with the screws. In the first of these† he considered a rigid body with freedom of the third order, and studied a representation of the screws in the system by means of three homogeneous co-ordinates, which may be compared to the trilinear co-ordinates of a point in a plane. In the second‡ he discussed the cases where there is a (1,1) correspondence between two systems of screws, and developed for these cases a general theory resembling the theory of homographic correspondence in geometry. In the third§ he applied the algebraical theory of emanants to screw co-ordinate transformations. In the fourth‖ he showed how certain problems in a system with two degrees of freedom could be studied by means of a merely plane construction. In the fifth¶ and seventh** he returned to the subject of displacements in elliptic space; and in the sixth†† he investigated the properties of the cylindroid by means of the theory of reciprocal screws. Four other short papers‡‡ written at this time (1886-1888) belonged to the astronomical side of his activity.

The principal series of memoirs was continued in 1886 by the sixth of the sequence.§§ In this Ball showed how the dynamical problems connected with the cylindroid can be solved by elementary plane geometry. The screws on the cylindroid are represented by

* "Note on a Transformation of Lagrange's Equation of Motion in Generalised Co-ordinates, which is Convenient in Physical Astronomy," *Monthly Notices* 37 (1877), pp. 265-8. "On an Elementary Proof of Lagrange's Equations of Motion in Generalised Co-ordinates," *Irish Acad. Proc.* 2 (1877), pp. 463-4. "Note on the Application of Lagrange's Equations of Motion to Problems in the Dynamics of a Rigid Body," *Irish Acad. Proc.* 3 (1879), pp. 213-4.

† "Preliminary Note on the Plane Representation of Certain Problems in the Dynamics of a Rigid Body," *Irish Acad. Proc.* 3 (1881), p. 428-34.

‡ "On Homographic Screw Systems," *Irish Acad. Proc.* 3 (1881), pp. 435-46.

§ "Contributions to the Theory of Screws," *Irish Acad. Proc.* 3 (1882), pp. 661-9.

‖ "On a Plane Representation of Certain Dynamical Problems in the Theory of a Rigid Body," *Irish Acad. Proc.* 4 (1883), pp. 29-37.

¶ "Notes on the Kinematics and Dynamics of a Rigid System in Elliptic Space," *Proc. R. I. A.* 4 (1884), pp. 252-8.

** "Note on the Character of the Linear Transformation which Corresponds to the Displacement of a Rigid System in Elliptic Space," *Proc. R. I. A.* 4 (1885), pp. 532-7.

†† "Note on a Geometrical Method of Investigating the Dynamical Properties of the Cylindroid," *Proc. R. I. A.* 4 (1885), pp. 518-22.

‡‡ "Notes on Laplace's Analytical Theory of the Perturbations of Jupiter's Satellites," *Proc. R. I. A.* 4 (1886), pp. 557-67. "Observations of Nova Andromedæ made at Dunsink," *ibid.* p. 641. "Note on the Astronomical Theory of the Great Ice Age," *ibid.* pp. 642-4. "On the Harmonic Tidal Constituents of the Port of Dublin," *ibid.* pp. 190-1 (1888).

§§ "Dynamics and Modern Geometry: A New Chapter in the Theory of Screws," *Cunningham Memoirs of the R. I. A.* No. IV., pp. 1-44 (1886).

points on the circumference of a circle, the angle between two screws is the angle which their corresponding points subtend at the circumference, and the shortest distance of any two screws is the projection of the corresponding chord on a fixed ray in the plane of the circle.

The seventh memoir, which appeared * in the following year, was a study of the cylindroid regarded as a conoidal cubic with one nodal line and three right lines in the plane at infinity: the treatment is geometrical rather than dynamical.

The eighth memoir† was a development of the first of the shorter papers already mentioned. It was published in 1889, in which year appeared also a German edition of the "Theory of Screws," by Herr Harry Gravelius.‡ This edition contained an account of all the memoirs down to and including the eighth, with original investigations by the German editor.

The ninth memoir, of date 1890, was entitled§ "The Theory of Permanent Screws," and contains the generalisation to screws of the well-known property of the principal axes of a single rigid body, that if the body be once set in rotation about one of these axes, it will continue to rotate about it.

The tenth paper‖ was published two years after Ball's translation to Cambridge, in 1892, and is devoted to the theory of certain invariantive expressions in the co-ordinates of screws, and to the notion of *chiastic homography,* which is a type of homography possessed by impulsive and instantaneous systems.

The eleventh memoir of the series¶ is occupied with the relations between impulsive screws and instantaneous screws; and the twelfth,** which appeared in the same year (1897), contains the long-sought-for geometrical method of finding the instantaneous screw from the impulsive screw, which was necessary for the complete geometrical method in dynamics.

This twelfth memoir was the last of the formal series. But we have still to notice a number of shorter papers which appeared in the intervals of publication of the later members, and also some memoirs of considerable length which appeared in the last twelve years of Ball's life.

Among the shorter papers a notable place must be given to the brilliant Presidential Address†† to Section A of the British Associa-

* "On the Plane Sections of the Cylindroid," *Trans. R. I. A.* 29 (1887), pp. 1-32.

† "How Plane Geometry Illustrates General Problems in the Dynamics of a Rigid Body with Three Degrees of Freedom," *Trans. R. I. A.* 29 (1889), pp. 247-84.

‡ "Theoretische Mechanik Starrer Systeme." Berlin; Reimer (1889).

§ *Trans. R. I. A.* 29 (1890), pp. 613-52.

‖ "The Theory of Pitch Invariants and the Theory of Chiastic Homography," *Trans. R. I. A.* 30 (1894), pp. 559-86.

¶ "Further Development of the Relations between Impulsive Screws and Instantaneous Screws," *Trans. R. I. A.* 31 (1897), pp. 99-144.

** "Concluding Memoir on the Theory of Screws, with a Summary of the Twelve Memoirs," *Trans. R. I. A.* 31 (1897), pp. 145-96.

†† "A Dynamical Parable," *B. A. Rep.* (1887), pp. 568-79. Certain extracts from this will be found at p. 242, *ante.*

tion at its Manchester meeting in 1887. This, which occupies ten pages of print, is really a complete popular exposition of the Theory of Screws cast into the form of a parable. The aspects in which the methods of space-geometry are superior to the methods of Cartesian analysis are most strikingly brought out. The address, which was immediately translated into Italian by Professor Vivanti, and later into Hungarian by Dr. Seydler, ranks as one of the best of Ball's minor writings. A number of other short papers * on related topics appeared in the succeeding period.

A new "Treatise on the Theory of Screws," to replace the one published in 1876, was published by the Cambridge University Press in 1900. It forms a handsome imperial octavo volume of 544 pages. Four memoirs† of considerable extent on the subject appeared in the decade following its publication; in the last of them, written in his seventieth year, he developed the connection, which Joly had pointed out, between the Theory of Screws and the quaternion theory of the linear vector function.

It must be remembered that during almost the whole of his working life Ball occupied the position of director of an astronomical observatory, and that much of his attention was given to observational researches which appeared in the official publications of the observatory. In addition to these, and to the mathematical papers which have been cited above, he produced in the latter part of his life various isolated astronomical papers,‡ some popular expositions§ of the subject, and a substantial treatise‖ on spherical astronomy, which was his last considerable work.

On a consideration of his mathematical researches alone, with which this note is primarily concerned, there can be no doubt that Ball will be regarded by posterity as one of the two or three greatest British mathematicians of his generation.

* "Note on a Determinant in the Theory of Screws," *Proc. R. I. A.* (3) 1 (1890), pp. 375-8. "On a Geometrical Illustration of a Dynamical Theorem," *B. A. Rep.* (1891), p. 566. "Note on a General Theorem in Dynamics," *B. A. Rep.* (1894), p. 561. "On a Form of the Differential Equations of Dynamics," *Austral. Assoc. Rep.* 6 (1895), pp. 215-7. "Note on Geometrical Mechanics," *Camb. Proc.* 8 (1895), pp. 240-1. "Amendment to the Twelfth and Concluding Memoir on the Theory of Screws," *Proc. R. I. A.* (3) 4 (1898), pp. 667-8. "Note on a Point in Theoretical Dynamics," *Camb. Proc.* 9 (1898), pp. 193-5.

† "On Further Developments of the Geometrical Theory of Six Screws," *Trans. R. I. A.* 31 (1901), pp. 473-540. "On the Reflection of Screw-systems and Allied Questions," *ibid.* 32 (1903), pp. 101-54. "Some Extensions of the Theory of Screws," *ibid.* pp. 299-366. "Contributions to the Theory of Screws," *Proc. R. I. A.* 28 (1910), pp. 16-68.

‡ "On the Cause of an Ice Age," *B. A. Rep.* (1891), pp. 645-7. "Relative Positions of 223 Stars in the Cluster χ Persei as Determined Photographically" (with A. A. Rambaut), *Trans. R. I. A.* 30 (1893), pp. 231-76. "Note on Mr. A. Y. G. Campbell's Paper 'On the Variation of Uncanonical Arbitrary Constants,'" *Monthly Notices* 57 (1897), pp. 118, 131.

§ "Starland" (1889). "The Cause of an Ice Age" (1892). "In the High Heavens" (1893). "The Story of the Sun" (1893). "Great Astronomers" (1895). "The Earth's Beginning" (1901). "A Primer of Astronomy" (1904). "A Popular Guide to the Heavens" (1905). "In Starry Realms" (1906).

‖ "A Treatise on Spherical Astronomy." Cambridge; 1908.

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